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LIMITATIONS OF THE COMMOM THEORY OF FLEXURE

THE DESIGN OF CURVED MACHINE MEMBERS UNDER ECCENTRIC LOAD

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THE article in the December number of MACHINERY on "The Design of Curved Machine Members Under Eccentric Load," as well as the original paper and the discussion in the *Journal of the American Society of Mechanical Engineers*, opens up an interesting subject to designers and draftsmen. The article referred to shows a remarkably close agreement between the results of the tests cited and the stress at the elastic limit as calculated by the formula of Messrs. Andrews and Pearson; however, the readers of MACHINERY will undoubtedly welcome further discussion of this and kindred subjects.

It is unfortunate that so many designers do not seem to thoroughly understand the limitations of the common theory of flexure, and persist in applying it beyond its obviously intended range of application. It cannot be too strongly emphasized that the common theory of flexure must be limited to stresses within the elastic limit, and that factors of safety for such parts do not show true ratios between the load at which ultimate failure would occur and the working load, as would be the case in simple tension members. For flexure,

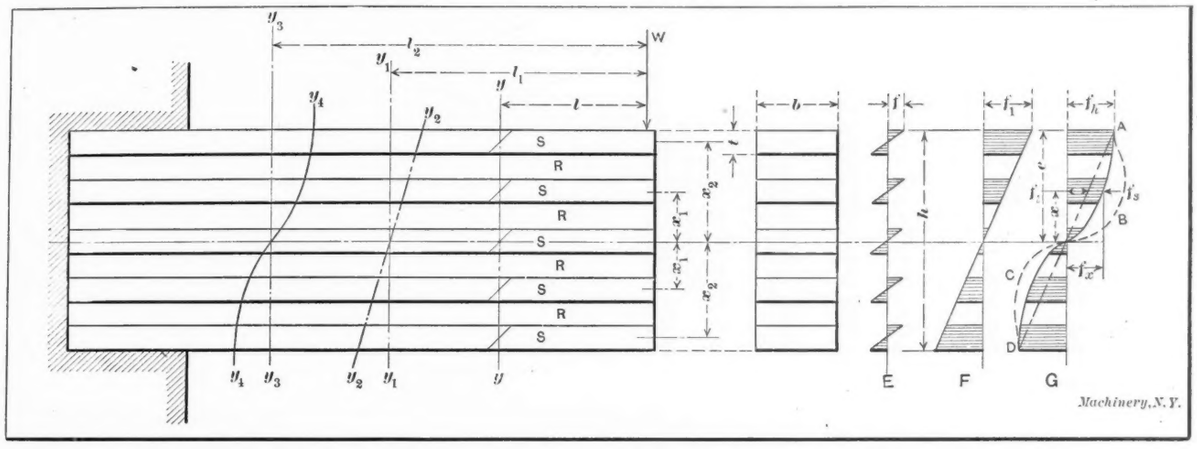

Fig. 1. Composite Beam for Illustrating the Influence of Horizontal Shear on the Distribution of Stresses over the Section

Stress Proportional to Strain

All analysis for the supporting power of members subjected to flexure is based upon Hooke's law of the proportionality of stress to strain, and hence is applicable only within the elastic limit, which "limit" is not always sharply defined. In fact, there exists no method of analysis whereby ultimate or breaking loads may be calculated for such members, and if it be desired to proportion such parts by basing the working load upon the breaking load, which is the usual conception of the significance of the factor of safety, it can only be accomplished by empirical formulas based upon tests of the ultimate strength of parts similar in form, of the same material and similarly loaded.

we should consider a factor with regard to the elastic limit instead of with regard to the ultimate strength of the material.

Effect of Horizontal Shear on the Distribution of Stresses

The common theory of flexure *assumes* that a section which is plane before flexure remains plane after flexure. While this may be practically true for beams with a span comparatively great in proportion to the depth, it does not necessarily hold true for short beams heavily loaded. For this reason it is not uncommon to find in bridge specifications an allowable fiber stress in pins about 50 per cent higher than that in tension members. One of the prime reasons for this will be found in the deformation due to shear parallel to the neutral axis. To give an elementary explanation of what is meant, pick up this magazine by grasping it at the back in one hand and attempt to hold it in a horizontal plane. It is found to be quite flexible—will not remain flat when so supported, be-

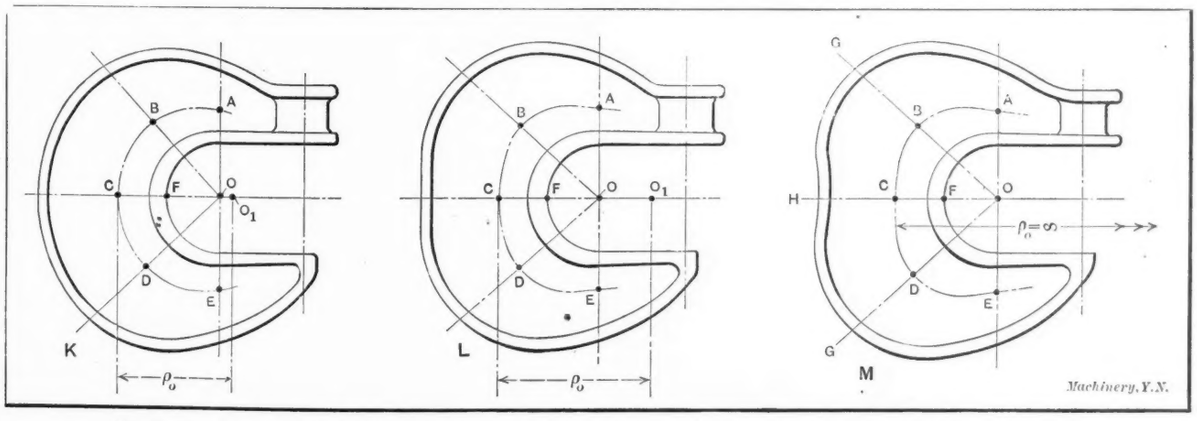

Fig. 2. Illustrations showing that the Curvature of the Gravity Axis does not bear a Direct Relation to the Flange Curvature

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cause the leaves are free to slide laterally upon each other; but if mucilage be applied to each leaf, and the whole thus united together, it would become quite as strong as a beam, and would be able to sustain considerable load.

A bundle of fibers such as a rope or a layer of leaves in an unbound book does not constitute a beam, because in neither case does there exist capacity for resisting shear parallel to the neutral plane. In any beam sustaining a vertical shear there exists also a shearing stress on all planes parallel to the neutral plane, this horizontal shear being zero at the extreme fibers and a maximum at the neutral axis; without such a horizontal shear there can exist no difference of tensile or compressive stress in successive layers of the material. (For a discussion of the intensity of this shear, based upon the common theory of flexure, see "Applied Mechanics," by Gaetano Lanza, pages 319 to 321.)

Any stress, be it tension, compression or shear, always produces a corresponding strain or deformation; consequently this horizontal shear is accompanied by a sliding of the "fibers" upon each other, and if this action were pronounced, it would completely demoralize the analysis for the extreme fiber stress as based upon the assumptions of the common theory of flexure.

To illustrate the foregoing, let Fig. 1 represent a cantilever of composite structure in which the layers S are of steel and the layers R of India rubber. Assume that the layers of rubber are not attached in any way to the layers of steel, and neglect any friction which may exist between them. The distribution of stress over the five layers of steel at any cross-section is then as indicated at E, and with five layers as shown, the extreme fiber stress in any lever at section yy, for these conditions, is $f = \frac{6Wl}{5bt^2}$, and, if N = number of layers of steel, $f = \frac{6Wl}{Nbt^2}$, or the supporting power is $W = \frac{fNbt^2}{6l}$. Now if h = height of section, and the thickness of the layers R be negligible, then $t = \frac{h}{N}$, and $W = \frac{fbh^2}{6lN}$, or with a given height of section the supporting power varies inversely with the number of layers and if the number of layers were infinite, corresponding to an infinitesimal thickness, the supporting power would be zero. The precise meaning of this is that a bundle of fibers does not constitute a beam.

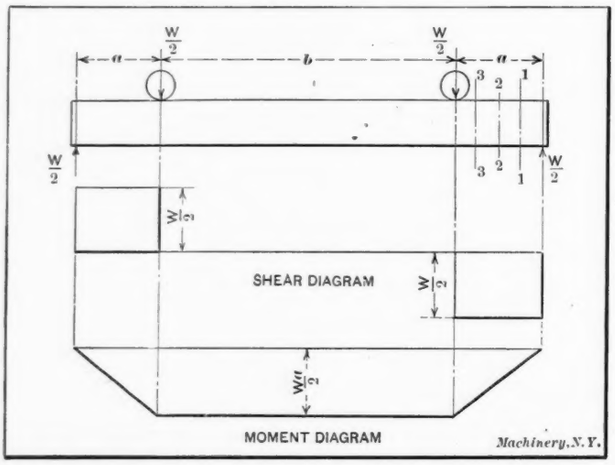

Fig. 3. Beam with Portion of the Span subjected to neither Vertical nor Horizontal Shear. The Stress in this Section, however, is built up at Sections where there is such Shear

Now assume that the layers of rubber R are firmly cemented to the layers of steel S, and that the rubber is absolutely rigid as regards shear in the horizontal plane but so elastic in tension or compression, when compared to the steel, as to be entirely negligible in this respect. Then any section, such as y_1y_1, which was plane before flexure, would remain plane after flexure, shifting to position y_2y_2, under action of the load W. This is one of the assumptions upon which the common theory of flexure is based, and for the case of the composite beam under consideration the distribution of the stress over the section would be as indicated at F. The assumption that the layers of rubber R are absolutely inflexible as regards horizontal shear is, however, obviously an assumption which cannot exist in fact, for in an actual beam of this nature the rubber would distort under this shearing action, and a section such as y_3y_3, which was plane before flexure, would not be plane after flexure, but would assume some position such as y_4y_4, and the stress in successive layers of the steel would not vary directly as the distance from the neutral plane. The distribution of stress over the section would then be somewhat as indicated at G. If f_b = the stress at the extreme fiber, and f_x = the stress on any fiber located at a distance x from the neutral plane, it is then obvious that the stress f_x is made up of two parts: first a stress f_t, which varies directly as the distance from the neutral plane; and second, a stress f_s, which is such as to cause a sliding of one layer upon another sufficient to transmit the horizontal shear. Then $f_x = f_t + f_s$ in which $f_t = \frac{f_b x}{c}$ while f_s is a function of several quantities, the precise mathematical relation of which has not as yet, so far as is known to the writer, been deduced. It can be stated, however, that the greater the vertical shear as compared to the bending moment, the greater the depth of section compared to its breadth, the greater the coefficient of elasticity for tension and compression as compared to the coefficient of elasticity for shear, and the smaller the value of x, the greater will f_s be in comparison to f_t. It is even within the range of possibility that for exceptional cases the maximum fiber stress may not occur at the extreme fibers but that the distribution of stress over the cross-section of the member may be as indicated by the dotted line $ABCD$, shown at G, Fig. 1.

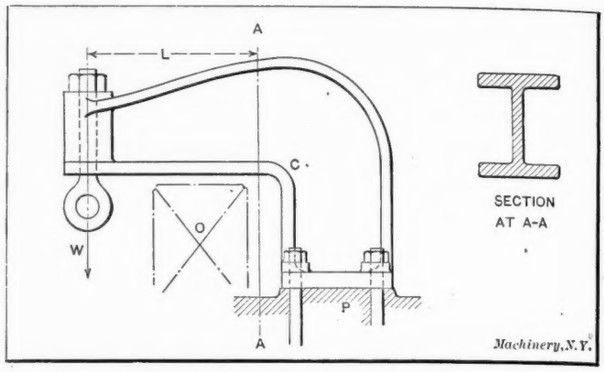

Fig. 4. The Mechanical Designer's Method of Constructing a Bracket

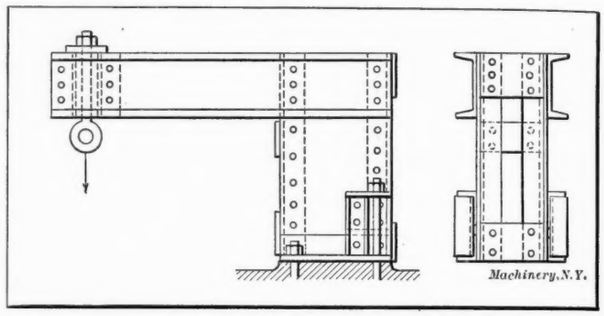

Fig. 5. The Structural Designer's Method of Constructing a Bracket. This Bracket is more Correct in Principle than that in Fig. 4

In any ordinary beam composed of homogeneous material, although it is not composite in structure as the example illustrated in Fig. 1, there are analogous conditions which the common theory of flexure entirely ignores because it is based upon the assumption that any section being plane before flexure remains plane after flexure. This assumption could only be justified by assuming the coefficient of elasticity for shear to be infinite when compared to the coefficient of elasticity for tension and compression, or else by assuming the length

of the beam to be infinite in relation to the height of the section. But as both of these assumptions are entirely at variance with facts, we must concede that the horizontal shear may have an important influence on the distribution of stresses over the cross-section; hence it is to be expected that the resisting moment of a short, heavily-loaded beam for a given maximum fiber stress would be considerably in excess of that given by the common theory of flexure, even when the stresses were well within the elastic limit. This accounts for the high allowable fiber stress in pins, as given in bridge specifications, as well as the apparent excess in strength of other short members subjected to flexure.

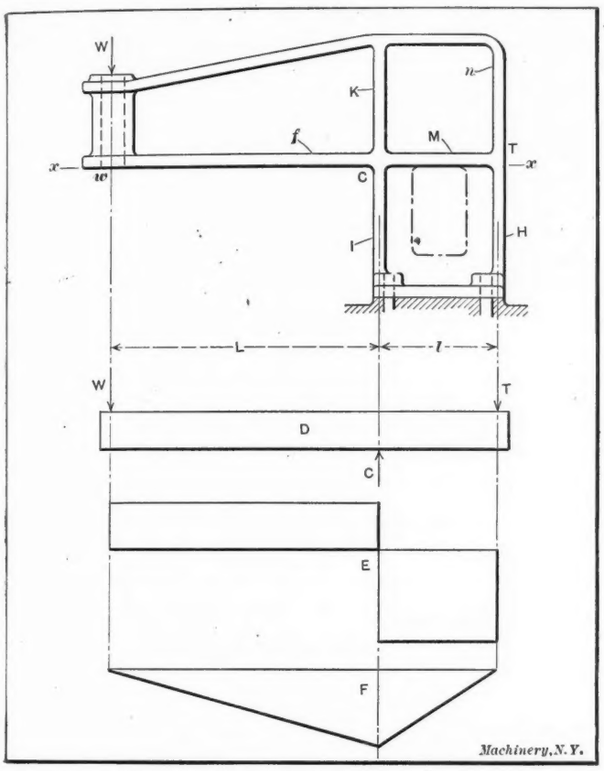

Fig. 6 A Cast Bracket designed along the Lines of a Structural Bracket

Stress Dependent Upon Conditions Outside the Plane of the Actual Section Under Consideration

Certain beams are, by reason of the nature of their loading, subjected to a constant bending moment over a considerable portion of the span upon which there is no vertical shear, and consequently no direct horizontal shear. One might be led to believe that for this portion of the member deformation due to horizontal shear could not possibly enter into the problem. Fig. 3 represents such a beam, and, while there is neither vertical nor horizontal shear between the two loads there is a heavy shear between each load and its adjoining support, as illustrated in the shear diagram. Now the stresses at section 1-1 are those incident to transmitting the vertical shear from the support to section 1-1. The stresses at section 2-2 are equal to those at 1-1 plus the additional stress induced by transmitting the shear from 1-1 to 2-2, etc. From this it is seen that anything affecting the distribution of the stress over the cross-section at 1-1 would also affect the distribution at section 2-2, 3-3, etc. The significance of the foregoing is that no stress due to flexure springs suddenly into being but is the result of a process of growth, and even though there be no vertical shear on a section, the stress in that section has been built up by reason of the transmission of such a shear in adjoining sections.

Crane Hooks

A crane hook is an exceedingly short beam very heavily loaded and, while there is no shear on the principal section, there is a heavy shear on the preceding sections which should be expected to affect the distribution of the stress over the principal section, so that, instead of this section remaining plane under load, it would be distorted. This, taken in conjunction with the fact that it is also a curved beam, is sufficient to completely demoralize the analysis if based upon the assumptions of the common theory of flexure. The analysis of Messrs. Andrews and Pearson takes cognizance of the curvature of the member through the theory of lateral contraction, yet assumes that the section remains plane after flexure, and therein the writer believes it to be at fault, notwithstanding the close accord between the calculated supporting power for a stress equal to the elastic limit and the supporting power at which the total deflection of the hook ceased to be proportional to the load as determined by tests.

The tabulated results of these tests given in the December, 1909, issue of MACHINERY, are here reproduced with the addition of factors of safety based upon the elastic limit. It will be noticed that five of the hooks were rated at capacities higher than the actual elastic limit as determined by the tests, while the other five were given rated capacities perilously near to this limit. It may also be observed that the sustaining power corresponding to an extreme fiber stress equal to the elastic limit, when that sustaining power is calculated by the usual Unwin formula, varies from 1.3 to 5.23 of the rated capacities, the average being 2.79. If we neglect the two strongest ones, the average of the remaining eight have a *calculated* sustaining capacity at the elastic limit of 2.23 times the rated capacity. This seems to indicate that the manufacturers of these hooks have been guided largely by experience rather than by an implicit but mistaken faith in the Unwin formula, and that they were proportioning and rating their hooks upon a basis of ultimate strength as determined by tests. The attitude of some designers is that they wish to design their hooks with a factor of safety based upon *ultimate* sustaining capacity, but they know the Unwin formula will not give this ultimate sustaining capacity, yet consider it to be the only well-known formula to apply. They therefore do the best they can with the available data by allowing a high working stress. If they were to concede that the analysis of Messrs. Andrews and Pearson was a more correct one than the usual Unwin formula, but yet desired to design with a view to safety against actual rupture only, instead of safety against the possibility of giving the material at the extreme fibers a slight permanent set, they would be little better off, if any. However, neither theory was intended to apply beyond the elastic limit and it is quite illogical to attempt to apply them in conjunction with factors of safety, so that if manufacturers wish to design crane hooks based upon ultimate sustaining loads, the only proper method of doing so is by using empirical formulas derived from actual breaking tests of a large variety of shapes and sizes.

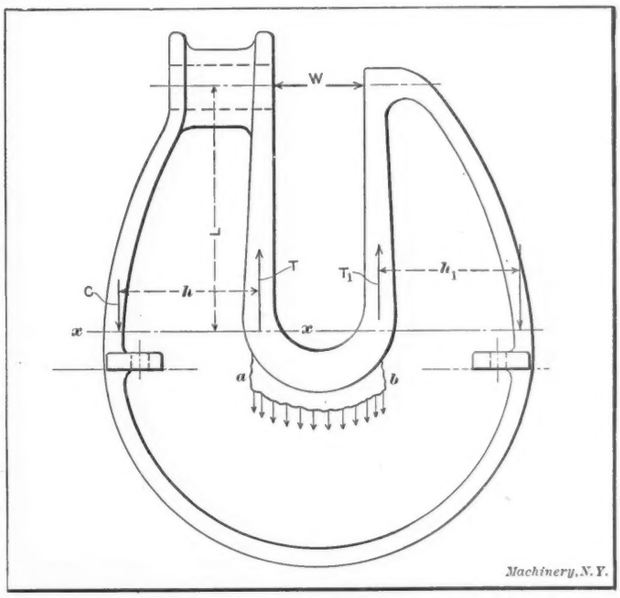

Fig. 7. A Riveter Frame Improperly Constructed. Forces T and T_1 are concentrated upon the Web between the Points a and b

Curved Members of Machine Frames

The frames of all such machines as punches, presses, shears, riveters, etc., which are under heavy load, are invariably box or I-beam sections, in which the major portion of the load is carried by the flanges. This makes the problem considerably different from that presented by a member of solid section, such as a crane hook and, even if we grant that the analysis of Messrs. Andrews and Pearson is correct for the former, it by no means follows that it is correct for the latter; for, while the radius of curvature of the gravity axis would bear a fairly well-defined relation to the radius of curvature of the most strained fibers in the case of such members as the crane hooks experimented upon, it bears no such relation in the case of machine frames in general. It follows that while the radius of curvature of the gravity axis may be a logical quantity to insert in a formula for crane hooks, it is not the curvature of the neutral axis we are interested in when it comes to general work, but the curvature of the flanges where most of the stress exists.

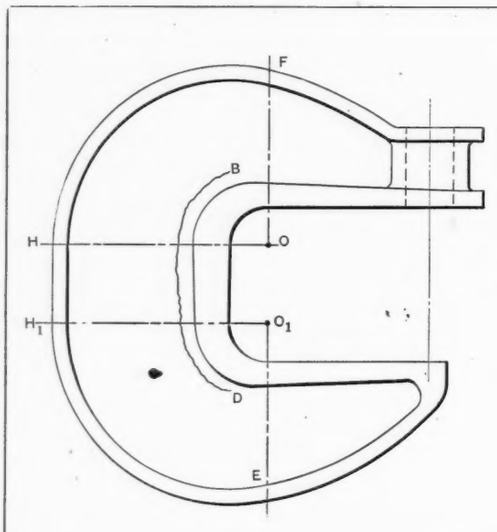

Fig. 8. A Small Portable Riveter Frame used for the Purpose of Illustrating Proper Design as indicated in Fig. 9

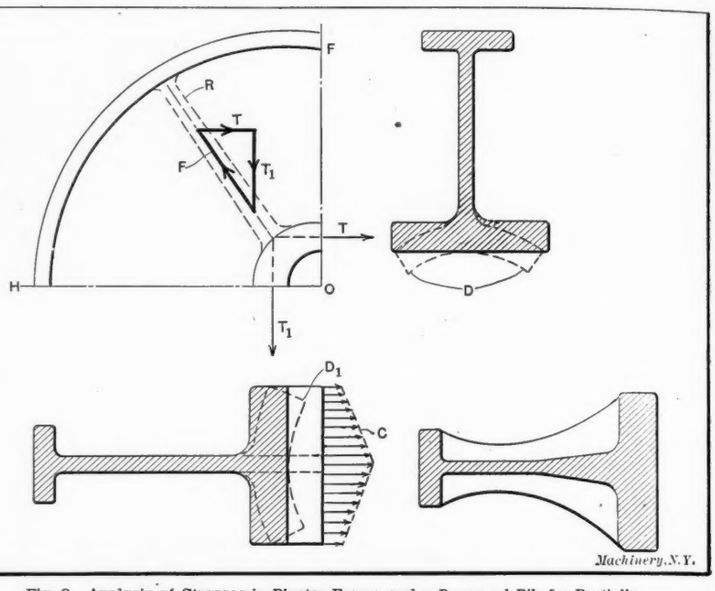

Fig. 9. Analysis of Stresses in Riveter Frame and a Proposed Rib for Partially Eliminating the Concentration of the Stresses in the Web

To illustrate the foregoing, Fig. 2 represents at *K* a frame with semi-circular throat in which curve *ABCDE* is the gravity axis of successive sections. Point *O* is the center of the throat radius while point O_1 is the center of a circular arc which approximately coincides with the gravity axis curve for points near to *C*. Then $O_1C = \rho_o$ = radius of neutral axis as it would be determined for insertion in the Andrews and Pearson formula, and this radius being comparatively small would give us a high fiber stress.

In Fig. 2 at *L* the throat radius *OF* remains the same as before but a portion of the rear flange is now straight, in consequence of which ρ_o has been materially increased, thereby reducing the extreme fiber stress. If we now go a step farther and actually make the rear rib concave, of such a curvature as to make the gravity axis at point *C* a straight line, as shown at *M*, we have ρ_o = infinity, and for this case the new formula reduces to the same form as the usual Unwin formula.* This would give an extreme fiber stress for the case at *M* of possibly one-third that at *K* if calculated by the new formula. Now in all three cases the throat radius remains the same and there would undoubtedly be as rapid a transition of stresses for the case at *M* as for that at *K* or *L*, yet the formula would give quite different results. This is because the quantity ρ_o in the formula has absolutely no mathematical relation to the flange curvature as it may exist in general work. Stated concisely ρ_o is not a function of *OF*. This, in the opinion of the writer, is sufficient reason for the rejection of the formula in its present form, at least for general work.

ANALYSIS OF HOOKS TESTED

Material of Hook	W_R Rated Capacity in Pounds	W_T Load at which Permanent Set Occurred as Determined by Test	W_S Load at which Permanent Set would Occur as Calculated by Standard Formula	W_N Load at which Permanent Set would Occur as Calculated by New Formula	$\frac{W_T}{W_R}$ Factor of Safety against Permanent Set by Test	$\frac{W_S}{W_R}$ Factor of Safety against Permanent Set by Standard Formula	$\frac{W_N}{W_R}$ Factor of Safety against Permanent Set by New Formula
Cast Steel	60000	56000	115000	55080	0.93	1.92	0.92
	40000	30000	70000	29925	0.75	1.75	0.75
	30000	48000	145000	50570	1.60	4.83	1.69
	20000	18000	43000	16500	0.90	2.15	0.83
	10000	18000	52300	18950	1.80	5.23	1.90
	6000	8500	14900	8600	1.42	2.48	1.43
	4000	4700	14900	4400	1.17	3.72	1.10
Average of Cast Steel					1.22	3.15	1.23
Wrought Iron	30000	16000	73000	15000	0.53	2.43	0.50
	20000	16000	26000	15000	0.80	1.30	0.75
	10000	14000	20800	14100	1.40	2.08	1.41
Average of Wrought Iron					0.91	2.91	0.89
Total Average					1.13	2.79	1.13

* This is, of course, an abnormal construction, but while improbable is not at all impossible; in fact the compression flange is often considerably less in area at point *H* than at points *G*, which has an effect upon the curvature of the gravity axis similar to a reverse curve in the rear flange, although not so readily seen.

Structural Engineering Versus Mechanical Engineering Methods

Generally speaking the use of curved members is improper construction when it is possible to avoid them, and structural engineers never put in curved tension or compression members, excepting in portals, or for ornamental effect, because they consider that force travels in straight lines or else produces bending stresses. On the other hand, designers of machinery seem to delight in curved ribs, bent levers and the like. In fact the average mechanical draftsman makes layouts as though he held the opinion that force travels along

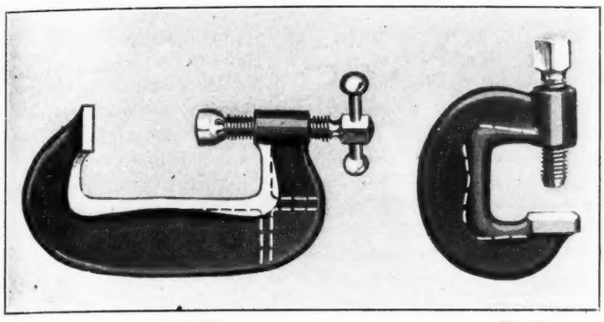

Fig. 10 Fig. 11

C-clamps as commonly designed and Indication of Suggested Improvements

a curved rib in a manner somewhat similar to water flowing in a pipe, and that it will, therefore, follow any course in which he may choose to distribute the material. The average structural draftsman may be absolutely helpless when confronted by some simple mechanical details, such as a shaft with its bearings or a set of bevel gears, but he would not be guilty of some of the improperly disposed curved members found in ordinary mechanical details.

To illustrate the foregoing, if a mechanical draftsman had a load W to be supported and a convenient place to put a pad P, but an obstruction O between the load and pad, he would probably construct a bracket similar to that shown in Fig. 4. For the stress on section AA he would apply the usual formula $S = \frac{WLe}{I}$ but would probably not give the second thought as to just how the stress "got around the corner" at C. Give the same conditions to a structural draftsman and he would produce something like that shown in Fig. 5. Here the corner is eliminated, as far as transition of stresses around it is concerned, the flanges are continuous, and, as shown, the rear bolts are not attached to a little lug ¼ inch thick, as one frequently sees, but the nuts rest upon a shelf angle supported by stiffener angles riveted to the vertical member with sufficient rivets to transfer in shear the calculated load on these bolts.

If the mechanical draftsman were to study the principles of structural engineering, he would make this bracket more like that shown in Fig. 6. With this construction the portion of the bracket above line xx may be considered a simple beam as shown at D, the shear diagram for which is shown at E and the moment diagram at F. With this construction I is a compression member sustaining a load $C = \frac{W(L+l)}{l}$ while H is a tension member the load on which is $T = \frac{WL}{l}$. The members K and n are stiffeners and serve to transmit the shear at C and T to the web. Note that flange f is not interrupted at the corner, as in Fig. 4, but is continuous, as it should be. The load on this flange is zero at w and T; it gradually increases to its maximum at C and it would be obviously improper to suddenly discontinue the flange right at its point of maximum load, which would be the case if member M were omitted, as was the case in Fig. 4.

A Riveter Frame

There is considerable analogy between the bracket of Fig. 6 and a punch or riveter frame, and the application of a little common sense should make it apparent that if we have a flange in tension or compression we must not suddenly give it a 90-degree or 180-degree bend and expect the stress in that flange to "go shooting around the corner like a cable car," but we must *provide means for the distribution of that stress* and carry it where it may meet an equal and opposite load to balance it; for no stress induced by flexure springs suddenly into existence or dies out suddenly; it is gradually built up and gradually dies out again.

The conception that no stress due to flexure springs suddenly into being is a direct result of the fact that all stresses due to bending are a function of length, *i. e.*, are the result of transferring the vertical shear from one point on the member to some other point.

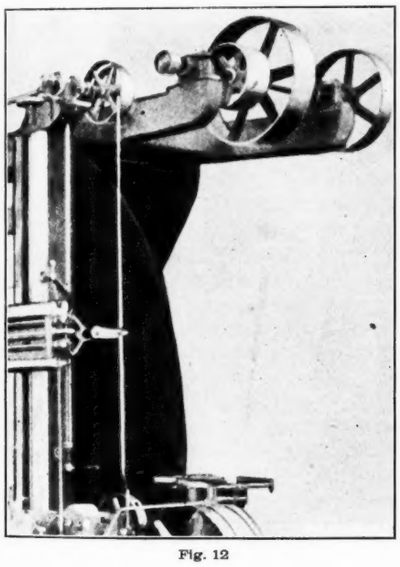

Fig. 12

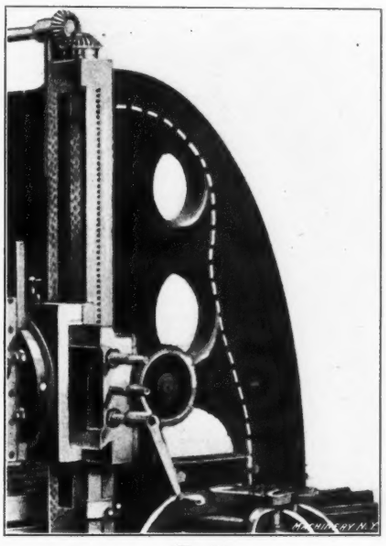

Fig. 13

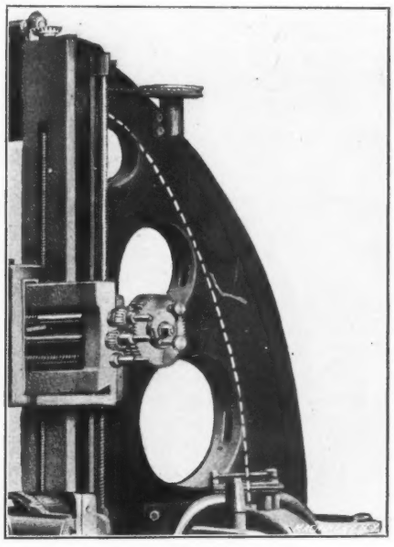

Fig. 14

Examples of Different Designs of Planer Housings

As an example of improper construction, take the bull riveter frame shown in Fig. 7. Here it is quite obvious that if the web were to part along the line ab there would be nothing to balance the loads T and T_1 in the tension flanges, and failure to balance these forces would mean failure for the entire frame. The total flange loads are, approximately, $T \cong \frac{WL}{h}$ and $T_1 \cong \frac{WL}{h_1}$, and if w = thickness of web, the average unit tension distributed over the web along line ab is $t \cong \frac{2WL}{hw(ab)}$, or, if h_1 does not equal h,

$$t \cong \frac{T+T_1}{w(ab)} = \frac{WL}{w(ab)}\left(\frac{1}{h}+\frac{1}{h_1}\right)$$

From this it would appear that the sectional area of the web along line *ab* should be approximately equal to the combined area of the *two* tension flanges and, were it not for the fact that it is necessary to thicken up the web at this point in order to avoid shrinkage cracks, there would probably be more frequent failures due to this improper construction.

In the case of a frame having a wider gap, such as shown in Fig. 8, the conditions are more favorable in this respect, for failure from this source would require that the web rupture from some point near *B* to some other point near *D*, which brings into action more sectional area of the web in proportion to the flange area than in the case shown in Fig. 7. This is, however, none the less an improper construction, because the sharp bend of the tension flanges between sections *OF* and *OH*, and between sections O_1H_1 and O_1E destroys the

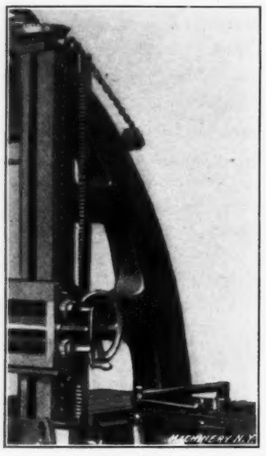

Fig. 15

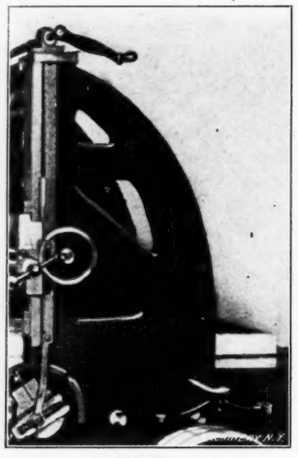

Fig. 16

Additional Examples of Designs of Planer Housings

continuity of these flanges for the direct transmission of stress.

To illustrate the foregoing, Fig. 9 shows that portion of the frame of Fig. 8 which lies between lines *OF* and *OH*. Now, let *T* and T_1 represent the total tensions in the flanges on sections *OF* and *OH*, respectively. By combining *T* and T_1 graphically, it is seen that a resultant force *F* must, in some manner, be supplied to establish equilibrium. The most direct way of supplying such a force is by the addition of a rib as indicated by the dotted lines at *R*, which will distribute part of *F* into the web, and deliver part of the force at the compression flange where there is a smaller opposing resultant force. In the absence of any such rib the necessary resistance must be supplied by the web, partly through a local bending and distortion of the flanges as indicated in an exaggerated manner by the dotted lines at *D* and D_1, and partly by a concentration of stresses towards the central portion of the flanges as indicated at *C*, this concentration being a direct result of the deformation at D_1.

In designing a rib *R*, if it were intended to carry the entire force *F*, it would be necessary to make it about 1⅜ times the average thickness of the flanges, but since the web can readily take half or more than half of the load, it would seem that a rib of ⅝ or ½ of the flange thickness, narrowed down at the center as shown in the lower right-hand corner of Fig. 9, would be entirely sufficient if the web were judicially thickened and liberal fillets used; however, it could scarcely be considered as correct in principle as the construction given for analogous conditions in the bracket of Fig. 6.

Steel C-Clamps

Another method of taking care of the local stresses induced at a bend in a flange is to thicken up the metal at the corner. This method is well illustrated by Fig. 10, which illustrates a clamp regularly on the market. Instead of thickening up the flange at the corners, the surplus metal so used could be put into two ribs forming a continuation of the flanges, as indicated by the dotted lines at *A*, and thus, instead of trying to transfer the stress around the corner, permit it to gradually "die out" in a natural manner. This would be the same in principle as the construction of the bracket shown in Fig. 6.

Fig. 11 shows a shorter clamp of standard manufacture. Here the weakest place on the clamp is obviously the corner, so that it would be possible to take away some material, as indicated by the dotted lines, without weakening the clamp. But the saving so effected would, in this case, be but a small percentage of the total weight, and such a form would detract from the appearance of the clamp; and anything which detracts from the appearance of a tool hurts its sale. For, notwithstanding the fact that when a part *is* right it *looks* right it is sometimes difficult to educate the eyes of those not conversant with analytical mechanics.

Planer and Boring Mill Housings

Figs. 12 to 16, inclusive, illustrate five designs of planer housings. These are of the same general design as used on large vertical boring mills and illustrate a misconception of the principles of mechanics. In Fig. 13 the designer evidently considered the housing as a cantilever with the load applied at the end, and aimed at a uniform extreme fiber stress, hence the parabolic form as indicated by the fullness of the curve at the top. Just what mental processes led him to place the holes through the housing in the irregular manner brought into prominence by the dotted line is, however, a mystery. The designer of the planer in Fig. 12 evidently realized that material is useful at the neutral plane, and the writer agrees with him in that respect.

In Fig. 14 the rear contour is noticeably flat at the top, as compared with Fig. 13, which indicates that the designer did not follow the parabolic form supposed to give uniform strength in such cases. The disposition of the holes shows that he aimed at a gradual increase in the sectional area of the rear flange, which, in this respect, is an improvement over that in Fig. 13.

Just what the actual distribution of stresses over the various sections of a member so formed might be, constitutes a very complicated problem which, at best, would be attended with considerable uncertainty. It can, however, be stated in a general way, that they are both designed upon the erroneous conception that the material at the neutral plane of a

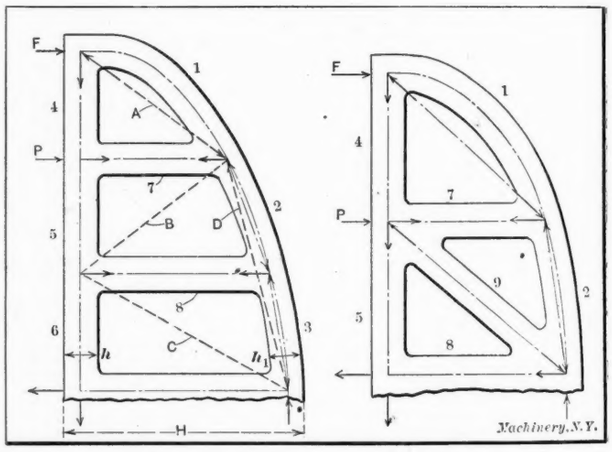

Fig. 17 Fig. 18

Analysis of Stresses in Planer Housings

beam is not under strain—hence is of no consequence, and should be removed if possible, on the score of economy. This is only another phase of the proposition that capacity for resisting shear on the neutral plane, and all planes parallel to it, is usually disregarded, notwithstanding the fact that it is a prime requisite in any member subjected to flexure.

Fig. 17 is an attempt at illustrating the internal forces in the housings of Figs. 13 to 15. When loaded at the top, as at *F*, members, 1, 2 and 3 are in compression and, in consequence of being curved, are eccentrically loaded struts. Members 7 and 8 are in tension while members 2, 3, 4, 5, and 6 are subjected to local bending in addition to direct stress. When the load is applied at *P*, members 2, 3 and 5, 6 are subjected to heavy bending action, and instead of having a beam of depth *H* it is more a case of two shallow beams of depth *h* and h_1. No such construction would be tolerated in structural engineering.

In Fig. 16 is shown a more modern type of planer housing in which the designer has pulled away from the stereotyped form and has approximated a true truss. He has not, however, had the temerity to eliminate the curved contour or make the center lines of his members intersect, and, while it is a step in the right direction, it does not go far enough to accomplish the ideal distribution of material.

Fig. 18 shows the principles underlying the construction of this housing. Members 1 and 2 are still eccentrically loaded struts, especially member 1, but members 4 and 5 would be plain tension members with the load at either *F* or *P*, if actually constructed as here shown. But in Fig. 16 it is seen that the center lines of members 7 and 9 do not intersect on the center line of members 4 and 5, and thus, as there constructed, members 4 and 5 are still subjected to a local bending action which might be avoided. For the application of the load at *P*, which is the usual run of work on a planer, this housing is almost ideal in its construction and should be very rigid.

The housing of Fig. 17 could be made a true truss by the straightening out of member 1, and the placing of members 2 and 3 in a straight line coinciding with *D* and the adding of members whose center lines are *B* and *C*. Member 8 could then be omitted.

Conclusion

To sum up the matter briefly:

1. No formula for flexure holds good beyond the elastic limit; hence ultimate supporting power cannot be calculated excepting by empirical formulas based upon tests.

2. No beam, unless a true truss, can sustain vertical shear without also possessing capacity for resisting horizontal shear; hence, do not cut away all the material from the neutral plane.

3. Horizontal shear must, of necessity, produce a corresponding sliding upon each other of the "fibers"; hence a section which is plane before flexure does not necessarily remain plain after flexure, and stress does not vary exactly as the distance from the neutral plane.

4. Short, heavily-loaded members should be expected to have a greater supporting power than that calculated by the common theory of flexure, unless crippling of the web be the determining feature.

5. No stress, due to bending, springs suddenly into being, but is built up from zero to a maximum by the transference of the vertical shear from section to section; hence anything which affects the distribution of stress on one section affects the distribution on succeeding sections.

6. Force travels in straight lines or else produces bending or other local stresses; hence curved members are to be avoided and it is entirely wrong construction to suddenly curve a flange without providing for the proper transference of the load in that flange.

7. A formula to take into account the stresses induced by curvature of flanges in compound sections should take into account the curvature of these flanges rather than the curvature of the gravity axis of the entire section.

8. Designers of machinery would do well to study the principles of structural engineering, use more straight members, fewer curved ones, and more nearly approximate true truss forms, thus securing more rigid members with less material.

* * *

An interesting method of making composite metal car wheels is in successful operation. The wheel produced has a manganese steel tread and a cast-iron web and hub. The practical result of the process is to produce an integral car wheel having a tread approaching in durability and strength a shrunk steel tire and costing much less. The principle of the process is substantially as follows: The mold is mounted on a vertical spindle and is rotated at a high speed when the molten metal is poured. The manganese steel is poured first and flows to the outside of the mold forming the flange and tread. Then the cast iron is poured to form the web and hub. The metals unite perfectly, making a sound casting, which, though variable in composition, is integral in physical structure. The wheels when struck with a hammer ring like a bell.

INEXACT MACHINERY TERMS

By T. S. BENTLEY*

T. S. Bentley†

No one who has had much to do with machine tool specifications can have failed to remark the great lack of uniformity commonly met with in the descriptive terms employed. In many cases this merely shows curious variations without causing inconvenience or ambiguity, but in others it renders the meaning obscure and occasionally quite misleading. The desirability of adopting recognized and uniform standards in matters calling for the cooperation of many separate individuals, has been generally felt and has led to the formulation of definite rules in many instances for the guidance of those concerned. Such standards have repeatedly proved their value and are daily growing in favor and in use.

There is room for a similar understanding in the naming and identification of machine tools and their various component parts. This would make for clarity in description, save much unnecessary correspondence, obviate a great amount of uncertainty and prevent many mistakes. In short, a number of definitions of terms relating to mechanical matters are urgently required.

A few cases in point will serve to illustrate what I mean and to suggest numberless other instances of things which call for definite settlement on some uniform basis. The first example which presents itself relates to that most common of all machine tools—the lathe—whose description shows striking differences of usage between engineers in England, America and the continent of Europe. English manufacturers invariably designate their lathes by "centers" (that is, the height of the center points above the flat topped bed which is regarded as standard form) and "length of bed." This description fails to give any really vital information either as to the capacity of the machine or even the amount of space which it requires. The nominal "centers" multiplied by two would indicate the maximum diameter that can be turned were it not for the fact that the bed is commonly made with a gap whose depth must be taken into account. The length that can be turned is less than the "length of bed" by a considerable but unspecified amount, while the over-all length exceeds it to an equally indefinite extent.

The American practice classifies a lathe by the "swing" and the "length of bed." The latter, as we have just shown, is useless for the purpose of conveying any precise information either as to capacity or extent; and the former is in reality almost equally indefinite. The swing is supposed to be the lathe's maximum capacity in diameter, but in practice there is often a considerable discrepancy between the nominal and the actual swing—so much so, that some lathes styled 16-inch will, in reality, accommodate work larger than can be turned in others that are designated 18-inch.

Continental practice usually gives "height of points"—corresponding with the English "centers"—and "distance between points," which latter does give a definite piece of useful information, *viz.*, the maximum length that can be turned.

As lathes are mostly bought primarily to do work of certain known dimensions, the best description would seem to be that which clearly indicates the actual swing and maximum distance between the centers. This information is required in order to judge whether the lathe under consideration is of sufficient capacity for the work which has to be done. If this

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is not directly stated, it must be arrived at by some form of computation or estimate—and the direct statement is certainly preferable from every point of view.

If we turn to planing machines, we shall find a similar want of uniformity in terms relating to them. Customers will mail a manufacturer inquiries for "a 4-foot planer," and leave him to guess whether width or length is intended. In either case the other dimensions should have been stated also, to make the description complete; and it would be no more trouble to ask for a 22-inch by 22-inch by 4-foot or a 48-inch by 48-inch by 10-foot planer, as the case might be, and leave nothing to chance. In such descriptions, the figures themselves usually indicate the order in which the dimensions are given, but it would be well to have a clear and general rule as to the order which shall be recognized as correct and assumed if not definitely stated. This would preferably be: First, width; second, height; third, length—which is already adopted by many makers of repute.

An understanding of this kind is now generally current with regard to the dimensions of articles such as emery wheels, pulleys, and milling cutters of ordinary form; and much unnecessary writing is saved thereby. The order adopted is: First, diameter; second, face; third, bore.

How essential it is that any such practice should be based upon a generally acknowledged rule, is exemplified in the matter of dates when expressed in the common and convenient form of say 9/1/09. To an American, this is merely a concise way of saying September 1, 1909, but an Englishman would read it as ninth January, 1909, unless well aware of the differing practice on the two sides of the Atlantic. Of course there can be no mistake about dates later than the twelfth of the month, but there is ample scope for misunderstanding among the dates which bear no internal evidence of their sense. Probably each method would be upheld by those accustomed to it, and neither party would desire to give way, but a uniform standard is certainly to be desired. Personally, I prefer the English method because of what seems to me its natural sequence, *viz.*, first the figure which changes daily and which gives the closest indication of the time referred to, then the figure which holds good for a month at a time, and lastly, the figure which needs changing only once a year.

But to get back to machine tools; perhaps no single word is more loosely used in this connection than "automatic," and its meaning is frequently open to misconception. Strictly speaking a machine is automatic when all its functions are performed by mechanism which is self-acting instead of being dependent on an operator; but the term is also used in a partial sense referring to some single feature only, such as feed-motion, throw-out, etc., and there is often uncertainty as to which idea is to be understood.

In drilling machines there are always two elements to take note of, *viz.*, power and capacity; both are important and either may be allowed to take precedence. Inquiries for drilling machines frequently give no more information than say "with a 2½-inch spindle," leaving type and capacity to the imagination of the person addressed. Of course, where there happens to be only one machine with that dimension, it may be all right, but often there are several dissimilar tools having this particular feature in common, in which case the matter becomes altogether vague. Another indefinite inquiry will call for a "5-foot radial"—which may mean one having an arm measuring 5 feet overall, or one which will drill to the center of a 10-foot circle, and the difference in price will be considerable. The latter interpretation is really the more legitimate, but there is a temptation (especially where price is known to be the deciding factor) for the maker or merchant to adopt that meaning which will come within the wording at the lowest figure. The result is that many times the customer eventually gets what he does not want, and the maker who offered what was really desired, loses the sale to the one who quoted rather to secure the order than to supply what the customer required.

In connection with milling machines, there is now substantial unanimity of description. A "universal" machine is now always understood to mean one having a swiveling table and spiral cutting apparatus, whereas some years ago at least one maker applied the term "universal" to millers such as are now dubbed "plain." There is one curious diversity, however, in naming the miller's horizontal slides, although the dimensions being so dissimilar, no misconception is occasioned thereby. The table being long and narrow, it seems only natural to describe its lengthwise motion as "longitudinal feed" and the one at right angles as "cross or transverse." Some people reverse this practice and call the short feed longitudinal and the long one transverse, cross or in-and-out. Evidently the one view is based upon the position and shape of the table, while the other labels all motions in relation to the spindle.

It is interesting to note, in passing, the conflicting practice in the arrangement of universal millers of the usual type, some being right- and some left-handed. Apparently this disparity has arisen in a similar way. The lathe was doubtless the parent of the milling machine and it can be employed for milling in two ways: Either the cutter can be mounted in the lathe spindle while the work is clamped to the carriage, or the piece to be milled can be held between the centers and a cutter-spindle rigged up on the rest. In the former case the cutters would naturally be made to run counter-clockwise—the normal direction of the lathe spindle—and the work centers made to suit; but the latter method would suggest the use of left-hand cutters.

The very terms "right- and left-hand" are particularly subject to confusion, and depend entirely upon the point of view. It would therefore be a distinct advantage to have some definite and simple rules drawn up for regulating their application and use. In the first place it should be clearly determined whether the terms right- and left-hand should be stated in relation to the machine itself or with reference to the operator who usually faces it and whose right hand is towards the left side of the machine. If we say that a lathe is in the right-hand corner of the shop, we mean the side corresponding to our own right hand as we look down its length; but if we speak of a right-hand side tool in that same lathe, we mean one which faces to our own left hand, *i. e.*, towards the right side of the lathe. [In American practice, a right-hand side-tool operates on the right-hand side or end of the work, the right-hand side being to the right of the operator when in the working position.—EDITOR.] The "front" of a lathe is the side on which the operator stands and is never a matter of doubt, but the "front" of a milling machine may stand for the end view of the spindle or either side according to design.

That this whole matter requires revision and standardization is plain from the misunderstandings which are constantly occurring, and from the fact that the terms right- and left-hand, whether relating to the rotation of a fan, electric motor, etc., the hanging of a door, or the objects in an illustration, are always matters of uncertainty or guess-work unless determined by some additional indication. To suggest a remedy which is at once practicable and effective is no easy matter, but we are told that "difficulties are made to be overcome," and some of the achievements in the direction of standardization which have already been accomplished looked at the outset far more hopeless.

It is useless to expect buyers of machine tools to be precise in their descriptions until the makers set the example of careful and accurate phraseology. Undoubtedly the machine tool builders must lead the way, and the first step towards the desired end will be in the direction of a standard system among themselves, preferably on an international basis. Their catalogues and printed matter would then do much to extend the result among buyers and others who could not be directly reached. The subject is one that might with advantage be taken up by the machine tool builders' associations with a view to some practical action, and I trust that they may be induced to take an active interest in the matter and endeavor to bring about its accomplishment.

* * *

The largest part of the world's supply of asbestos is provided by Canada. The total amount of asbestos produced yearly in the world is about 75,000 tons, of which Canada produces about 65,000 tons. Russia produces practically the remainder, or about 10,000 tons.

GRITS AND GRINDING CHIPS*

Whether grinding the roughest work, such as draw-bars, alloy steel railroad switches, frogs, etc., or the finest and most delicate instruments of precision, the abrasive used, whether it is a grinding wheel, oilstone, or razor hone, removes the metal by cutting off minute chips. Each little particle of grit on the abrading surface is a cutting tool, which severs the chips on the same principle that the lathe tool removes metal.

The secret of the success of any abrasive wheel or stone is in the adaptability of its structure for the work on which it is used. The efficiency of aluminous abrasive materials used in the manufacture of grinding wheels depends largely on their purity and structure. By aluminous abrasives is meant those which depend for their abrasive action on the alumina content. The chief impurities found are the oxides of iron and titanium and silica. In some cases these minerals are merely intermixed with the abrasive and can easily be separated mechanically. In other cases the impurities are chemically or mechanically combined with the abrasive grain, so that purification is practically impossible. In all aluminous abrasives, the abrasive efficiency is directly proportional to the amount of crystalline alumina present. When silica is combined with alumina, it makes a brittle grain of weak structure which is unsatisfactory, and when iron oxides are present the grain lacks the necessary abrasive qualities; the tendency of such a wheel is to heat or burn the material being ground, and it also consumes a great deal of power.

Fig. 1. Microscopic View of Emery Grains containing 50 Per Cent Crystalline Alumina

Fig. 2. Alundum Grains containing from 92 to 98 Per Cent Crystalline Alumina

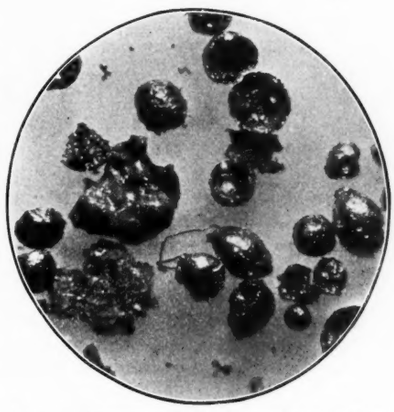

Fig. 3. Manganese Steel Chips produced by Dry Grinding with an Emery Wheel

Fig. 4. Manganese Steel Chips produced by Dry Grinding with an Alundum Wheel

In Fig. 1 some grains of Naxos emery are shown as they appear under the microscope. These grains have a considerable quantity of foreign minerals and they may be compared to a sponge, the interstices of which have been filled with impurities. The abrasive shown in Fig. 2 has only a small amount of combined impurities, none of which are mechanically mixed and it will be noted that these grains show a tendency toward crystallization, whereas those in Fig. 1 are entirely amorphous, that is, they have no determinate shape. It is evident that the more round or blunt grains shown in Fig. 1 are not as good for abrasive purposes as those of Fig. 2, which have sharper cutting edges. All the commercial forms of natural abrasives have impurities of foreign material to a greater or less degree. They seldom have more than 85 per cent crystalline alumina and those that run as high as 80 per cent or over are considered exceptionally good. The common grade of emery used has only from 40 to 50 per cent crystalline alumina. In the artificial aluminous abrasives it is possible to get any degree of purity desired, as the purity depends on the electric furnace treatment. Alundum has from 92 to 98 per cent pure alumina.

In Figs. 3 and 4 are shown two lots of grinding chips as they appear under the microscope. Those shown in Fig. 3 were taken from under a grinding wheel made of an abrasive material similar to that illustrated in Fig. 1. The other chips shown in Fig. 4 were produced by a grinding wheel composed of an abrasive material of a high degree of purity. The material from which these chips were ground was the same in both cases and the grinding was done under the same conditions. Fig. 3 shows that there was so much heat generated that portions of the chips were melted as indicated by their

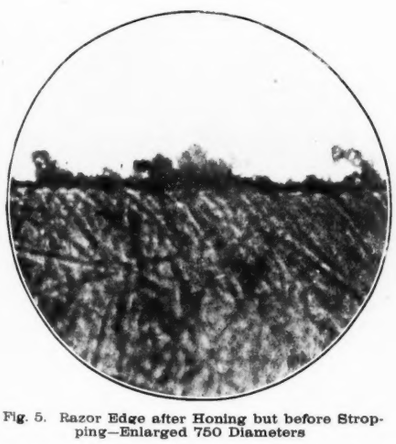

Fig. 5. Razor Edge after Honing but before Stropping—Enlarged 750 Diameters

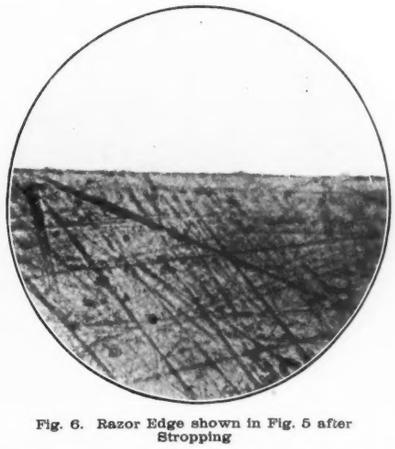

Fig. 6. Razor Edge shown in Fig. 5 after Stropping

Fig. 7. Edge of Razor shown in Figs. 5 and 6 Honed on Coarser Hone and Stropped

*Abstracted from the March and April numbers of *Grits and Grinds*, published monthly by the Norton Company, Worcester, Mass.

globular form, while those of Fig. 4 are seen to be, in form, identical with the chips from steel metal cutting tools, except that there are many different shapes, widths and lengths due to the fact that the cutting points of the grinding wheel are differently shaped and have different clearance angles. It is not intended to infer that the cutting properties of a wheel depend entirely on the abrasive, for there are many conditions that should be considered, as for example, the grade of hardness. That the quality of the abrasive is of considerable importance, however, is shown by these microscopic views.

The microscope and camera also furnish evidence that in the act of grinding, the principle of the cutting action is the same, whether a grinding wheel, oilstone, polishing and buffing wheel, or razor hone is used. For example, a keen edge on a knife or razor is produced by cutting from the side of the blade minute chips until the blade is worn down to a thin edge, and the chips differ from those produced by a coarse wheel only in size. Chips from two widely different forms of grinding are shown in Figs. 4 and 5. The first illustration shows the chips obtained from grinding with a coarse open wheel, while the second shows the edge of a razor that has been honed but not stropped, the photograph being taken under the microscope and enlarged 750 diameters. What is seen on the edge of this razor are minute particles of metal or chips clinging to the slightly magnetized edge. Fig. 6 shows the same razor after having been stropped. It will be seen that this operation removes the tiny particles of metal shown in Fig. 5. The even edge of the razor after honing is evidence that it was sharpened on a fine hone of even structure. Fig. 7 shows the same blade with a different edge, but having been honed on a stone of coarse and uneven structure and then stropped. It is plainly evident by these illustrations, which are magnified the same, that the hone used on the blade of Fig. 7, is made of coarser grit than that used on the blade of Fig. 6, as the edge is rougher and the marks on the side of the blade are deeper.

The form of chips produced by metal grinding indicates to a certain extent the temperatures at the point contact. If the chips are spherical instead of being long and curly, the heat generated has been excessive and a cooler cutting wheel should be substituted, as energy in the form of motive power is being consumed unnecessarily. Where there is too much heat generated, there is also danger of overheating and burning the work. Excessive heat and waste of power frequently result from the use of wheels that are too hard or too fine for the work. The combination of a hard bond and fine grit makes a wheel so dense that there is little opportunity for the particles to project enough to cut and there is no room for chips if they were removed. Such wheels, however, last longer than the proper grade and for this reason there is a tendency on the part of those economically inclined to use hard, fine wheels on work which calls for wheels which are coarse and soft, but this is poor economy. In this connection the microscope and camera have proved valuable in determining the proper wheel or stone for the various kinds of work. It is possible by this means, together with a similar examination of the surface ground, not only to select the grade and grain of wheel that does the work most effectively, but in many cases to improve grinding conditions in general.

* * *

IS THIS TRUE?

"It is a curious fact that it is immensely more difficult to write a good news article about a subject of which you yourself know much, than about a subject on which you are looking for information, as well as everybody else. I myself once wrote a book on how to run a steam engine (published anonymously) and though I had never touched a steam engine in my life, my book at once took precedence in popularity over all the other books on the market written by experts and was adopted in colleges as a text book."—*Sherwin Cody.*

* * *

The French army department has recently acquired an automobile which is capable of running as well in water as on land. It can be instantly changed from a land to a water machine. It has a speed of twenty-five miles on land and about eighteen miles in water, and can carry four persons.

REORGANIZING A RUN-DOWN ASSEMBLING DEPARTMENT—2

By ALFRED SPANGENBERG*

In the previous installment of this article, the necessity for analysis of existing conditions, the relation of the machine departments to that of assembling, the value of an efficient stock tracing system, the importance of an inspection department, and wage systems, received consideration. The present installment will deal with problems encountered in the assembling department itself.

2.—DEFECTS OF ASSEMBLING SYSTEM AND METHODS FOR IMPROVEMENT

Arrangement and Equipment of an Assembling Room

The efficient organization of a shop requires the division of the shop into departments according to the machines used; for instance, the lathes should all be in one department, and so with the planers, milling machines, etc. A large number of concerns, however, still machine a part of the work in the assembling room, even though regular machine departments have been established for the machining operations. This leads to inefficient methods of machining in the assembling room, as the machines can generally be used to better advantage if installed in the proper machine department. This matter was fully treated in an article by the writer appearing in the August, 1909, issue of MACHINERY.

Again, the average assembling room is small, and the space taken up by operating machinery is generally needed for assembling work or for storage. In most cases, the reason given for having machine work done in the assembling room, is that difficulties arise in getting the parts promptly to the assemblers; if the machines are in the assembling department, delays will be avoided, because the assembling foreman will take particular care to get the work out in time. While this, no doubt, is true, yet, with an efficient stock tracing system, there should be no difficulty in obtaining the work from the machine departments in time.

Occasions will also arise in the assembling when it is necessary to adjust some of the parts, and it is then advantageous to have machines convenient to the assembler. Upon investigation it will generally be found, however, that much of this work is unnecessary and can be eliminated by the employment of a few simple gages.

In describing the arrangement and equipment of the machine tool assembling department, we will assume that the operations involved will include the cleaning and chipping; drilling; filling, rubbing down, and painting; assembling the small units; scraping; and erecting. As these operations differ widely, each being performed by a different class of workmen, a proper system requires their segregation. In large shops devoted exclusively to building one article these operations usually are carried on in separate departments, each under a different foreman. The usual plan where the product is of a varying character, is to have a separate assembling department for each class of machines; thus, in the machine tool line the lathes are erected in one department, the planers in another, etc. The last-mentioned plan is the one that will be considered here.

Cleaning and Chipping Operations

In some shops the cleaning and chipping is done in the assembling room, although it is more economical to clean the castings in the foundry, owing to the cheaper class of labor employed and the better facilities for this work. However, when this work is done in the assembling department, a suitable space should be provided, so as to keep the "muss" and dirt in one place. The old-time method of cleaning large castings by rubbing them with a file or emery brick should be supplanted by the more economical method of using an emery wheel driven by a portable motor and flexible shaft. The equipment should also include stationary emery wheels for grinding the small parts, and pneumatic hammers for chipping the heavier work. Vise benches and vises are needed by the chippers, and suitable stands or bins for the small parts will economize space.

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As all castings should be cleaned thoroughly before any drilling or assembling operations are started, this work should be located near the receiving depot and convenient to the drilling machines, as nearly all castings require some drilling operation.

The filling, rubbing down, and painting, can be done to advantage in the cleaning space; these operations should be completed immediately after the drilling, and before the assembling operations are commenced. In many shops, however, the painters are allowed to fill and rub the finished or partly finished machines, to the annoyance of the assemblers, and with the certainty of getting dirt in the bearings. Of course, some of the painting and touching up with filler must be done on the assembling floor, but in most cases it can be confined to one place.

Drilling Operations

If special shop conditions render it advisable to have the drilling machines in the assembling department, they should be located near the place where the work is received. The

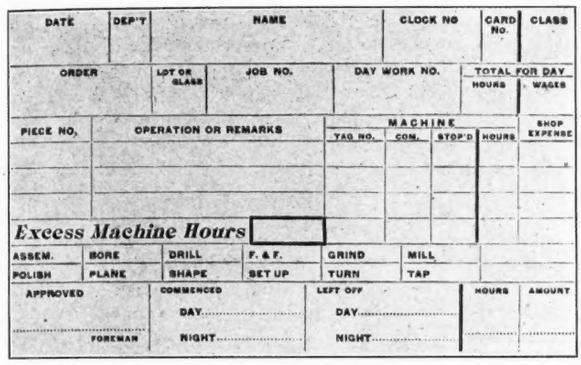

Fig. 4. Card which accompanies the Work until it reaches the Stock Room. The Necessary Operations are numbered consecutively and checked off as completed.

general arrangement of the machines and the requirements for their operation were outlined in the writer's article in the August, 1909, issue. Rapid drilling is essential, as some one of the assemblers will always be found waiting for the drilling operations to be completed. High-speed steel drills and *machines powerful enough to drive them to their maximum capacity* are, therefore, required.

Assembling

Even when the assembling and erecting processes are carried on in one department, it is best to provide a separate location for each, because the equipment for each differs widely. For assembling the small units it is convenient to have long benches on which to place the parts; these benches are provided in addition to the regular wall benches with vises, and should be arranged convenient to the latter and with aisles between them for trucking the work. These aisles should always be kept clear. When the parts are made in large quantities, it pays to provide fixtures for holding the parts that cannot be conveniently clamped in the ordinary vises during the assembling process. For holding the heavier pieces, as, for instance, lathe headstocks, trestles or wooden horses are required, which may be made of sufficient length to hold three or four headstocks. The space under the trestles can be utilized for keeping the smaller assembled units until needed.

The practice of allowing the benches to be littered up with small parts and stock supplies such as screws, pins, keys, etc., is a source of loss and waste. One of the greatest causes of annoyance to a foreman when this system, or rather lack of system, is followed, is that the workman soon forgets what members the stock supplies belong to, with the result that screws are used that are either too long or too short, or not of the right type. This defect may be overcome by providing boxes of uniform dimensions for keeping the small parts. These boxes should be made with a partition at one end for the stock supplies, and with a tin pocket on the side in which to place cards giving the necessary information, as will be explained in detail later.

Much time will be saved in the assembling department by having a specific place for such tools as wrenches, pneumatic drills and hammers, clamps, etc. While the men should be permitted to help themselves to these tools, they should be returned upon completion of a job. Little or no trouble will arise from lost tools if the foreman insists upon this rule being enforced. When there is a departmental tool-supply room, it is better, of course, to keep all tools there. Ratchet wrenches with removable sockets fitting different sized nuts, bolts, and screw-drivers, are most convenient for assembling work.

All parts to be assembled should be arranged in logical order and placed convenient to the workmen, so that their sole attention can be concentrated upon the assembling operations, thereby making it unnecessary for them to waste time in running around to find the parts. Every facility should be provided for the quick handling of the work.

Scraping Operations

The work of scraping usually does not receive the attention that its importance demands. The accuracy of the work produced by any machine tool is almost entirely dependent upon the accuracy with which the planed surfaces are scraped; it is essential that a proper equipment of straightedges, surface plates, test indicators, squares, etc., be provided for testing the truth and alignment. Each individual member should be tested separately, and it is often advisable to have special straightedges or surface plates which can be used both for testing the planing and scraping. Then the planing is easily tested, and if not within the allowable limits, the part can be sent back for replaning before any scraping is done. This is an important feature, since it is far more economical to plane work true than it is to scrape it.

Without the aid of such devices for gaging the work, errors may exist in the machining that may necessitate the use of a file before the scraping operation. These special straightedges or surface plates are, however, not intended to make the parts interchangeable in all respects. It is practicable only to carry out this feature in the planing process and up to a certain point in scraping, after which the pieces are scraped together and numbered accordingly.

In addition to trestles for the heavy parts, scraping trucks are convenient for supporting the movable members during the scraping. These trucks are portable benches mounted on castors, so that they can easily be moved about and turned around to any position that will secure good light on the work. Motor-driven, rotary oil stones should be provided for the sharpening of the scrapers. Each scraper-hand should be provided with a number of properly hardened scrapers. The necessity for ample crane facilities is too well recognized to need comment. Simple and inexpensive pulling devices, such as those described by the writer in the April, 1909, number of MACHINERY (reprinted in MACHINERY'S Reference Series No. 50, "Principles and Practice of Assembling Machine Tools"), will greatly facilitate this work, and enable the workmen to devote their energy to the actual operation of scraping.

Erecting

The arrangement of the erecting floor will vary with the character of the work; however, a few general principles may be stated. Where it is the practice to build machines in large lots, the beds are placed in rows with aisles between. Crowding should be avoided; in case there is not sufficient room to arrange all the beds in a lot on the erecting floor at one time, fill the available space without crowding, and store the remaining beds in some convenient place.

Suitable erecting pits are required for such machines as large boring mills and planers, which have driving works reaching below the floor line. The bottom of the pits is usually lined with concrete, with sides of the same material or brick, while cast-iron plates are placed all around the mouth. These pits are generally provided with movable girders or supports, to accommodate various sizes of machines. When a pit is not in use, it is covered with a plank floor made in sections, supported upon the girders set in pockets in the sides of the pits.

Emery wheel stands, speed lathes, small drill presses, and

portable vise stands should be located at convenient points on the erecting floor. Chalk, emery cloth, machine oil, and all special appliances used by the workmen should be handy, so as to avoid running to the tool-room. In regard to waste for cleaning purposes, it may be of interest to note that many shops are now abandoning it for raw silk towels which can be washed in a machine, and, besides being cheaper in the end than waste, are far more sanitary.

The relative importance of handling facilities, such as electric cranes, hoists, etc., varies according to the character of the work. What may be the most important feature for one class of work may not be essential in another class. In some cases it pays to have specially designed jib cranes with power hoists, so that the workmen need not wait for the over-head crane after the work is once placed within reach of the former.

In the handling of light work there are several points of im-

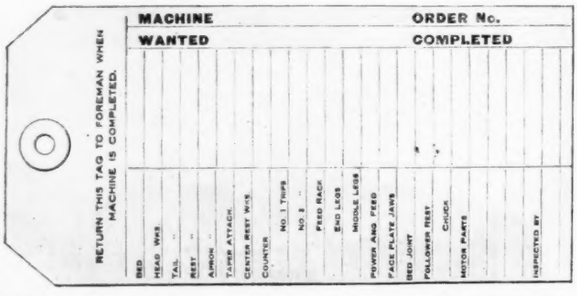

Fig. 5. Tag showing Data required by Erectors. The Tag Illustrated is for Engine Lathes; when properly filled out, it is placed on the Lathe Beds on the Erecting Floor

portance that must be considered. Whenever possible the stock should be carried in boxes. These boxes should be of some standard sizes. For very small work it pays to arrange the boxes with removable trays so that the stock can be easily handled and better protected in carrying it through the shop. Erecting trucks with one or more shelves, and ordinary two-wheeled trucks are necessary for moving the light pieces. The features mentioned in this brief outline apply to the entire assembling department, and are of vast importance because an astonishingly large proportion of lost time can be attributed to lack of proper facilities and methods for handling work.

As all power-driven machinery requires to be "run off" when completed, some convenient source of power is necessary. This problem is easily solved in the case of motor-driven machines, but for belt drives, instead of moving each machine under a countershaft, it is more convenient to provide portable electric motors, which can be moved to any machine by the crane. If required, these motors may be back-geared and provided with different-sized pulleys, and in the case of small units the entire outfit can be mounted on a truck. When the machines to be run off require the application of power to more than one pulley, a suitable countershaft can be supported above the motor by braces bolted to the truck. Each outfit should be provided with a controller, as variable speed motors are best adapted to this work.

Necessity for a Departmental Stock-supply and Tool-room

One of the principal factors in the efficiency of an assembling department is the stock-supply and tool-room—the "heart of the department." Added to the loss of time in looking for lost or missing parts, due to haphazard methods of checking up and taking care of the parts as they are received, it is the usual custom in run-down assembling departments not to provide any regular place for keeping the work, but to dump it down anywhere. Frequently the only place provided for the small parts is under or on top of the vise benches.

When sufficient space is available for a stock and tool supply room in the assembling department, it is advisable to establish one immediately. In equipping this department, adjustable metal shelves and bins can be used, and for storing many of the small parts carried in the boxes already referred to, racks can be so arranged that any box can be placed directly into the rack in the same manner as a drawer. This arrangement saves extra handling of the work, and is better than piling boxes one on top of another, as any box is instantly accessible. The shelves and bins in the stock room are only for keeping the smaller parts, such as can be easily handled by the stock clerk; the larger pieces, not being so apt to get lost or misplaced, can be taken directly to the assemblers without passing through the stock room, although care should be taken in checking up this material when received.

Sufficient space should be assigned in the tool-room for storing all tools used in the assembling department. Some simple system must be inaugurated for keeping track of the work and avoiding delays in giving it out, for taking proper care of the tools and keeping them in good condition, and for charging up to the workmen the tools in their possession. A part of the space assigned to the stock and tool supply room should be partitioned off and fitted up for the foreman's office, as the foreman necessarily must keep in close touch with this department.

When the size of the department precludes the establishment of a stock-supply and tool-room some other place with suitable equipment must be assigned for keeping the small parts until wanted by the assemblers. Either wooden or metal shelves and bins should be erected near the receiving depot, and they should be numbered consecutively to facilitate putting the parts into the bins and locating the work when wanted. All of the larger pieces should be stamped with their order number and pattern or forging numbers for the purpose of identification in the shop and for the customer's convenience in ordering repairs. As it would not be feasible to stamp the stock supplies, such as screws, pins, etc., with their piece number, it is of advantage to have the stock supplies put up in suitable packages properly tagged. This can be done at odd times by the stock clerk, and the packages placed in the proper bins together with the members to which they belong. In case there are too many pieces belonging to any particular group for one bin, two or more bins can be assigned to the large groups. This matter should be determined in the beginning.

Methods of Routing the Work

In shops without established methods of routing the work, it frequently occurs that work reaches the assembling department without having all the machining operations completed, and if this is not discovered before the parts are put away,

Machine: 21-inch Turret Lathe. Part: Feed Works. Time: 80

Group: Friction Gear Members. Group No. 92.

Name of Parts	Operation	F or P	Dr. No.	Q	Need.	Stock	Q
Pinion		P 23212	1758	1		Key	1
Collar	Drive	P 23249	"	1			
Friction Gear	Run	P 35685	"	1			
Friction	Slide	P 35686	"	1			
Nut	Erector will adjust	P 17188	"	1			

Fig. 6. Specification for Friction Gear Members shown on the Assembly Drawing in Fig. 7

time will be lost when the work is finally delivered to the assembler, and, in addition, unnecessary trucking is required. This is particularly likely to happen where there is no system of inspection, and the sequence of operations is not mapped out in the beginning on cards or tags, as shown in Fig. 4, which accompany the work in its course through the shop.

The receiving depot in the assembling department should consist of a long bench about the height of the moving trucks, for convenience in placing the small parts; the truckers who bring the work to the assembling department are merely required to put it on this platform, as the stock-room clerk may not always be in a position to immediately check up and dispose of the parts. He should, however, give a receipt for all work entering his department, these receipts being returned by the truckers to the respective machine departments, to be placed on file as evidence that the work had reached its destination. Cards for this purpose must accompany the work, and

the receipt may be given in the form of a distinctive punch mark, or with a rubber stamp. The data this card should contain are shown in Fig. 1, in the May issue.

As soon as possible after the work reaches the assembling department it should be disposed of in a proper manner. All small pieces that require cleaning and painting are sent to the cleaner's bench; those requiring drilling and no cleaning or painting are sent to the drilling machine and piled in a convenient place; all other small parts are placed in the stock-room bins. After being cleaned, the work is sent to the drill presses, and all small work as soon as drilled, is delivered to the stock room. Thus no work enters the stock room until ready for the assemblers. Large, heavy pieces are sent directly to the drilling machines and from there to the assembling or erecting floor. A regular place should be provided also for the large parts, as otherwise much unnecessary handling will result. It is advisable to mark or tag these parts, for identification, with their group number in addition to the piece and order numbers.

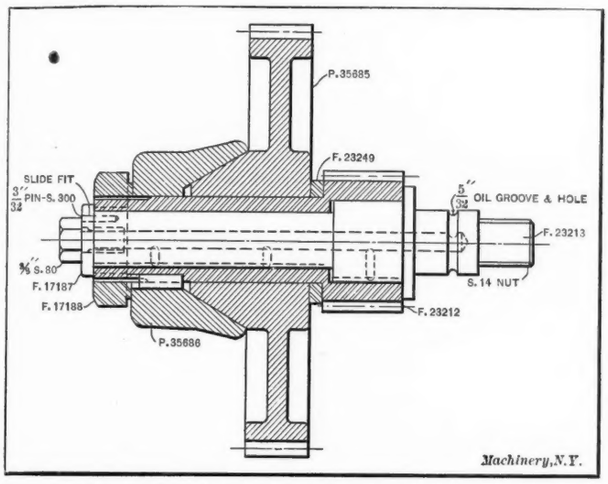

Fig. 7. Assembly Drawing of Parts Classified in Fig. 6

The Assembling Operations

When work is to be delivered to a workman who is nearly ready for his next job, the foreman or the job-boss sends a helper to the stock room with a work card properly filled out. This card contains the date, workman's name and number, group number, piece numbers, names of the parts to be assembled, operations, contract price, and estimated time for assembling. The stock room clerk delivers the parts to the helper, who, in turn, delivers them to the workman together with the card just mentioned, any shortages being noted on the card. All small pieces are carried in the boxes mentioned, which remain with the workman until empty, when they are returned to the stock room. The writer believes it unwise to provide the workmen with assembly drawings except under special conditions, as considerable time is wasted in studying the drawings. Better results are obtained by a proper subdivision or classification of the parts that can be assembled independently, each group containing a small number of pieces, so that only a few verbal instructions on the part of the foreman are necessary. This opinion is strengthened by the fact that comparatively few workmen can read an assembly drawing. Moreover, instructions should only be necessary in the case of new work or new men. All assembly drawings should be kept in a suitable cabinet in the foreman's office.

After each group is assembled, any parts requiring scraping are taken apart and sent to the scraper-hands, while all the remaining pieces are taken directly to the erecting floor and placed convenient to the bed of the machine to which they belong. Thus the erectors are supplied with work as soon as it is assembled. The parts that require scraping are immediately sent to the erectors upon completion of the scraping operations. This, of course, applies to the smaller members; the heavy members and beds of the machines are scraped on the erecting floor to save extra handling. The scraper-hands and erectors are furnished with contract tickets similar to those given to the assemblers.

On some classes of work, as, for instance, large lathes and planers, it is the practice to duplicate only the *parts* in quantities, because machines of this character have beds made to order, the lengths varying considerably. In this case, the parts when assembled are sent to a stock room for finished work, and kept there until a machine is ordered, when they are sent to the erectors to be fitted to the bed. The completed machines having passed final inspection, are then placed in the hands of the shipping department. The tag which is placed on each machine on the erecting floor is shown in Fig. 5.

It will be observed from the foregoing that the workmen are always supplied with jobs, and the work is not allowed to remain with a workman after he has finished his operations on it; it is immediately sent to the next operator. This condition fulfills a fundamental principle underlying the management of men—that they should ever feel the pressure of work yet to be done, and their inability quite to meet the demand ahead of them.

Method of Assigning the Work

Two fundamental principles of economical assembling must be recognized in the apportioning of the work among the workmen so as to secure a rigid subdivision of labor, and in the avoiding of unnecessary delays in getting work to the men, *before they are ready for it.* In fact, if nothing more were accomplished in reviving a run-down department than the constant supplying of the workmen with plenty of work and the necessary tools, and having the jobs classified and arranged in logical order, the productive capacity of the department would be considerably increased. Yet, in average cases the foreman gives these matters little consideration, resulting in work being assigned to high-priced workmen that could as well be performed by cheaper men, and in wasted time while the foreman hurriedly chases around looking up jobs for men who are out of work. In this way, work is often assigned and commenced without regard to whether or not it is wanted first, and without ascertaining the fact that all the parts belonging to any particular job are received and ready for the assembler.

It now remains to formulate plans whereby the work can be assigned and distributed with the least amount of attention on the part of the foreman. At the outset it will be necessary to group or classify the parts which are to be assembled. This task can best be accomplished by the assembling department foreman, since no one is as well qualified to successfully carry

21-inch Turret Lathe Driving Works

Name of Group	Wr.Recd.	Wr.Assem.	Assem.by	Index
Inter. Driving Gear Members				I 25
Inter.Driving Gear Stud Members				I 26
Sliding Pinion Clutch Members				I 27
Clutch Yoke Members				I 28
Clutch Handle Members				J 29
Rack Sleeve Pinion Members				J 30
Back Gear Shaft Members				J 31
Back Gear Clutch Members				J 32

Fig. 8. Part of a Group Index Page from which the Work is assigned

out this important work as he. The most convenient way to make the classifications is to take the assembly drawings and thoroughly analyze the operations necessary to assemble the machine. The classification of grouping of the parts and assembly operations will be made with reference to the correlated members, *i. e.*, members which can be assembled or fitted independently of other parts. In making these classifications, it is advisable to make as large a number of divisions or groups as possible; for instance, a large semi-automatic turret lathe easily would comprise 150 to 200 groups.

The primary objects in making such a large number of groups are to provide for a rigid subdivision of labor, and to enable the rate setter to arrive at a more accurate determination of the time required to assemble the various parts. The secondary advantages derived from the system are that exces-

sive time spent on any particular operation can be detected at once and the cause located; there is likely to be less discrepancy between the estimated time and actual time; it enables all the small members constituting each group to be kept in a separate bin in the stock room so that the parts can be delivered to the workman in logical order, thereby avoiding the necessity of sorting over a large number of pieces when giving out the work; and the task of assigning the work becomes a comparatively simple matter, as only a small number of parts are in each independent group; and a subdivision of this character facilitates the assembling operations by permitting different jobs to be started as soon as a few parts are received.

In mapping out this work, effective use can be made of a loose-leaf book, which enables rapid arranging and indexing of the groups. The general classification of the data may be seen from Fig. 6, which shows the tabulation of the friction gear members in Fig. 7. The stud F. 23213, washer F. 17137, ⅜ screw No. 80, and 3/32 pin No. 300, are not included in the form shown as they belong to another group of parts. As will be seen by referring to Fig. 6, the parts are arranged in logical order the same as they are to be assembled, which is the plan that should be followed in preparing the part lists for all the groups. The column marked "Recd." is to be filled in with lead pencil, so that the same page can be used for any number of machine lots, provided no changes in design are made.

After tabulating all the groups belonging to one machine, they should be arranged in logical order, classified, numbered consecutively, and a list compiled for ready reference. From the specimen page shown in Fig. 8, it will be seen that columns are provided for "Wk. Recd." and "Wk. Assem.," which furnish the foreman with a continual record of the condition of the work, and enable him to ascertain instantly just what groups are ready to be assembled, and when the work is ready for the erectors. This record is kept up-to-date from data secured from the stock-room records and piece-work tickets. As occasion requires, the foreman fills in the column marked "Assem. by," from which his clerk is enabled to make out the proper contract, which should accompany the work when it is delivered to the workman. Another index is required giving the pattern and forging numbers in numerical order together with their group number. This is to facilitate putting the work into the proper stock bins. A copy of this index, together with a list of parts belonging to each group, is needed for the stock room, but the loose-leaf record book must always be kept in the foreman's office.

General Requirements for Efficient Work

It is the intention to here but briefly show the practical working of an inspection system in the assembling department for insuring efficient, economical, and accurate production. At the outset it will be necessary to provide the inspectors with the necessary tools and gages for the rapid and accurate inspection of the work assembled and erected. There should be some regular system whereby the gages, both those in use by the workmen and those in the inspector's care, will be examined carefully at certain intervals and compared with the master gages to ascertain whether or not they have become worn. The reference gages or standards of comparison should be kept by the head tool-maker or by some one especially appointed for that work. This person should determine how often a gage must be examined to insure its being in the proper condition; and by arranging the examinations periodically, accuracy of the tools and gages can in this way be very easily insured. In addition to supplying the inspectors with the proper tools and gages, some safe and convenient means must be provided for keeping this equipment and transporting it around the department. This can easily be accomplished by furnishing each inspector with a portable desk, mounted on wheels, and having suitable drawers with lock and key in which to keep the various tools, gages, printed forms, writing materials, etc.

The inspectors' duties on the assembling and erecting floor consist primarily in examining the fit and alignment of the various shafts, gears, slides, guiding surfaces, etc., and to see that every part of the machine functions properly. This, of course, necessitates the constant and watchful attention of the inspectors as the work proceeds, so that faulty workmanship is discovered in its early stages. Even the matter of looking after such seemingly unimportant details as the proper tightening of nuts and bolts should receive attention, for when this point is neglected, it often happens that through carelessness on the part of a workman, a machine "falls apart" after being used a short time, causing trouble and annoyance to the customer, with the result that the next time he is in the market for a similar machine, he in all probability buys another make. Steel stamps bearing a distinctive character should be furnished the inspectors for marking all work passed upon by them—these stamps, under no circumstances, to be out of their jurisdiction. This acts as a check upon the inspector, for if any defective work passes his hands and bears his stamp he is responsible for any future trouble arising therefrom.

In connection with the question of determining just what limits of error are allowable, it is interesting to note that in modern machine tool practice the tendency is to allow greater limits in running fits than was thought advisable a few years ago. Thus, for all rotating members, except main spindles carrying the work or tools, the practice is to allow from 0.002 to 0.004 inch for running fits, for diameters from ¾ to 3 inches, according to the requirements of the case; to have a lateral clearance, or endwise motion, of 0.005 inch for shafts, gears, or pulleys, running between bearings, sleeves carrying gears, etc.; and to cut the teeth of all gears thinner than standard, so that two gears when in mesh will have a slightly perceptible amount of backlash.

The advantages of this practice are at once apparent; it not only results in ease and quickness of assembling, but the main feature to be considered is the fact that when the bed of a machine is under the severe strains of a heavy cut, the distortion likely to occur may cause the rotating members to bind in their bearings, if fitted too closely, and thereby consume an excessive amount of power, besides overheating in the case of high rotative speeds. Moreover, so much time will be saved in assembling these parts, that an extra amount of time is allowable for obtaining accuracy in the alignment and fit of vital members, such as main spindles, slides, and guiding surfaces.

Conclusion

Turning now to the subject of reports and their uses, it may be stated that much good can be secured from a simple yet thorough system of reports by the assembling foreman, based upon his actual experience in carrying through his department a newly designed product, these reports to contain criticisms and suggestions upon design, and ease and economy of assembling the parts. This will result in establishing comprehensive and business-like cooperation between the designing department and the assembling foreman and assurance will be obtained that when a new or re-designed machine is produced it will operate properly, and will be so designed as to be produced in the most economical manner possible.

The problems involved in reorganizing a run-down department must be solved with an absolutely unbiased mind and a determination to analyze the situation thoroughly and mercilessly. If any superintendent or foreman wants to determine the fact that many of the defects in methods and management mentioned in this article in all probability apply to his own shop, let him, *after ascertaining what should be accomplished make a comparison with his present methods and processes.*

* * *

HIGH-SPEED STEEL FILES

The expert file maker knows full well how easy it is to ruin a new file by a few quick strokes on hard castings. After a file has been used for some time the same treatment perhaps would not appreciably harm it. The delicate sharp edges of new file teeth are easily ruined by impact and heat, whereas after some wear, they are much less likely to be affected by injudicious use. A new file used on revolving work in the lathe, especially cast iron, is quickly worn out unless used with discretion. It would seem that for such purposes files made of high-speed steel would be much superior to the common brands, but, of course, much more costly, although not more expensive, perhaps.

LATHE BURNISHING OF METALS

By WILLIAM A. PAINTER*

The burnishing of metals while not requiring the skill of the spinner, or the multiple operations or tools used in that craft, still is a trade that is separate and distinct from spinning. Metal burnishing can be divided into three classes:

1. Hand burnishing of irregular shapes, such as tableware, jewelry, belt buckles, metal clocks, ornaments and all metal parts that cannot be revolved on the lathe, using steel hand tools of various shapes.

2. The burnishing of small round work in the lathe, such as buttons, ornaments, etc.—mostly plated ware that has already been surfaced and is operated on to brighten only—not requiring the heavy pressure of the tool, and being mostly done with blood-stone burnishers, a natural stone of small size mounted in a steel holder. These stones, some of which are very expensive, last for years.

3. The burnishing of unfinished or rough work in the lathe, which requires smoothing and polishing at the same time; this requires considerable pressure. The blood-stone burnisher would be ruined on this class of work. The tools used are of steel and the handles are short; they are held in the hand only. A strong wrist and muscular arm are required for burnishing, as well as a steady feed of the tool, which is partly accomplished by the movement of the body, in conjunction with the arm and wrist motion; the hand is steadied by being held against the body.

Burnishing may be described as an economical way to finish, polish or brighten the surface of metal, without wasting any of the material. It is also a means of strengthening the

Fig. 1. View showing Method of Moistening Work with Finger Pads and also Position and Angle of Burnishing Tool

metal by tempering or hardening it; this is accomplished by pushing the tool over the work, beginning at the front end and pushing always against the chuck. The toolpost is used as a fulcrum and the tool, which is pressed against the work, as a lever. The tool is given a slight rotary motion, and only the thin edge or end is used.

While the pressure against the work does not seem great, still the area in contact with metal is so small, and the speed of the lathe so high, being from 3200 to 5000 revolutions per minute, that the tool leaves a bright mark. The skill of the operator lies in passing the tool over the metal so as to leave a continuous bright surface without any trace of the tool marks; to do this the tool must be fed with regularity and without overlapping or leaving any dull places.

After sheet metal is spun, or drawn in presses, the smooth, even surface which it has when it comes from the mills is changed to a rough, uneven surface having high and low spots which are hardly noticeable to the naked eye, but very easily distinguished under the magnifying glass. The working operations distend or elongate the molecules, and the annealing operation restores them to their original shape. Some shells are annealed several times before the burnishing operation is reached, besides being pickled after each annealing to remove the scale; this leaves the surface of the metal in a pebbly or matted condition, as well as soft and without temper.

A spun shell can be gone over with a planisher, and hardened, but the scale and dirt is crowded into the grain of the metal, and the only way to get a smooth surface is to buff or cut it down until this pitted face is removed, thus wasting about 10 per cent of the metal. The spinner can do this in another way, that is by skimming or shaving the uneven surface, but even more metal is wasted than by buffing, and the shell is also weakened by gouging the high places. This same shell could be left without polish, and the chuck transferred to the burnishing lathe, which runs at much greater speed than one used for spinning. After the shell is dipped bright to remove all spinning dirt and scale, it can then be polished to an even surface, the uneven face of the metal being amalgamated

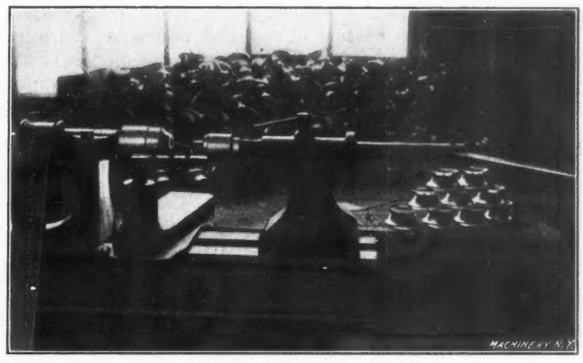

Fig. 2. Burnishing Lathe Equipped with Split Chuck

or smoothed down to a bright surface of the proper temper; it is then colored with a cloth buff to obtain a perfect finish. The gage or thickness remains the same as there is no dirt or scale to buff out.

Burnishing is economical, especially on pressed or drawn work made in large quantities, some work being finished at the rate of five hundred or more an hour. It is necessary to have a metal chuck in burnishing, and where the shell has been spun on such a chuck, the latter can be used for both operations. Some work can be lacquered without coloring on the buff wheel, the only operation after burnishing being to wash in hot water and dry at once in hot sawdust.

A burnishing lathe is smaller than a spinning lathe, and it has only one speed. The countershaft is fastened to the floor under the lathe; this is necessary on account of the great speed, besides a down-pull of the driving belt causes less vibration than the up-pull of a belt from an overhead countershaft. The speed of burnishing lathes is varied for different classes of work. In a group of four lathes in use in our factory one is belted to run at 5000 revolutions, two at 4000 revolutions

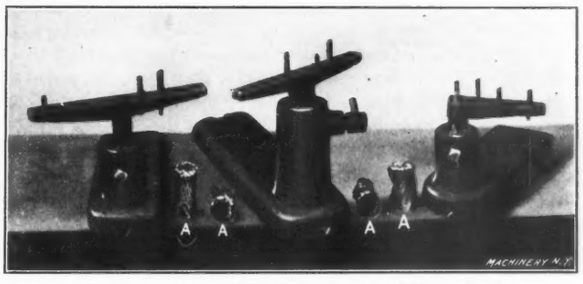

Fig. 3. Burnishing Lathe Steady-rests and Finger Pads

and one at 3200 revolutions a minute. Lathes for very large work of 12 inches and over in diameter have straight babbitted bearings, with a back screw and button to take up the end shake. The babbitt has to be renewed about once a year for continuous service, only the best grade being used. All threads on the spindles are of one standard size, the chucks being interchangeable for the burnishing and spinning lathes.

In some shops it is customary to have a small stream of water running on the work above the chuck, the connections being hinged, so that the stream can be guided above the tool. A back center is used to hold the work against the chuck. The operator wears a rubber apron to protect himself from the flying water, and stands in a shallow trough that has a drain. The great speed of the lathe throws off all surplus water, leaving only a thin film next to the metal—all that is necessary.

This article describes a method of burnishing that is used in many shops. The shells are first dipped in a tank of

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water, which is on the bench back of the lathe head; they are then held on the chuck by the left hand, the thumb and first three fingers being covered with canvas pads. These pads are dipped in the water and are held opposite the burnishing tool and slightly in advance of it to keep the metal moist, thus leaving no surplus of water to be thrown off. The hand also holds the work against the chuck instead of the back center. Sometimes on large work it is necessary to dip the pads in the water a second time; also where a very fine polish is wanted it is necessary to pass the tool over the work twice, roughing it down on the first pass and finishing it on the second, using the same tool without taking it off the chuck.

Fig. 1 shows the method of using the pads on the fingers and also the proper position and angle of the tool, as well as the height of tool-post or rest. The chuck shown is 8½ inches in diameter and weighs 36 pounds; it runs at 4000 revolutions per minute. The shell has been gone over twice.

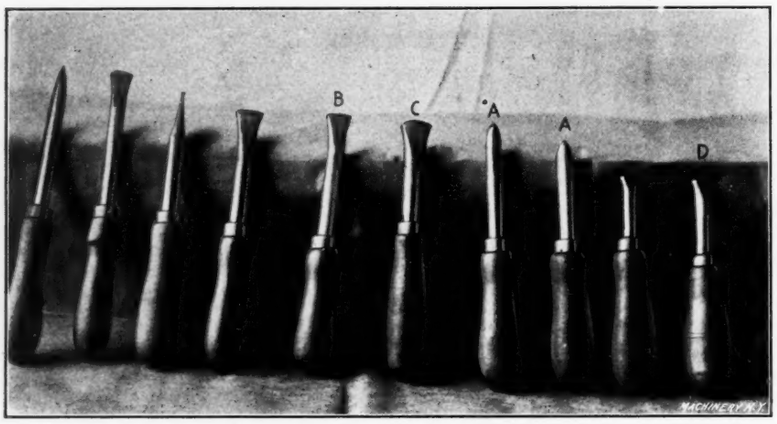


Fig. 4. Group of Tools used for Burnishing

Fig. 2 shows a burnishing lathe equipped with a split chuck, one part being in the tail-spindle and having a roller end bearing similar to the one described in the preceding installment of this article. All chucks for burnishing are like the spinning chucks, except that greater care must be taken in machining them to have them perfectly balanced.

Fig. 3 is a view of the steady-rests that are used on burnishing lathes. These are different from the spinning rests, for while the spinner uses only one pin as a fulcrum, changing it from one hole to another as the work advances, the burnisher uses several pins of much smaller size, inserting as many pins as he needs positions for the sweep of his tool. These pins are about ¼ inch to 9/32 inch in diameter and are tapered 2½ degrees on the end which is inserted in the cross-bar of the steady-rest, the holes also being tapered and the pins driven in tight. The canvas finger cots that are used on the left hand to moisten the work, are shown at *A*.

Fig. 4 shows a group of burnishing tools, some of which are of high speed steel, and others of regular tool steel. These tools are made extremely hard and no temper is drawn. They project out of the handles from 2½ to 5 inches and are ⅜, 7/16, ½, and ⅝ inch in diameter. The handles are 4 to 5 inches long and 1⅛ to 1½ inch in diameter. The round tools *A* are used on heavy work; also to get in sharp corners and to burnish shells which are part plain and part embossed, requiring the tool to be lifted from one part of the work to another to avoid the embossed area. *B* is a flat tool with a slight curve on the end; it is used mostly on straight work and convex surfaces. *C* is a flat tool with a greater curve on the end, and it is used mostly on concave surfaces, while *D* is a flat tool with a still greater curve on the end, for use on small curved work, such as that shown in Fig. 5. These tools have to be polished when they get coated with metal, the interval between polishings depending on the texture of the metal worked and its temper, a shell that has been annealed several times coating the tool more than one that has not. It is a quick operation to polish the end of a burnisher. A board of soft wood or a strip of leather fastened to a board and to the bench, in a position convenient to the operator, is used. Grooves are worn into the leather or board, and flour of emery and oil, or flint flour and water is used to clean the tools, a few passes of a tool being all that is necessary to polish it.

Fig. 5 shows samples of burnished work; some of these are spun but most of them are drawn in presses. The bright dip which is used to clean work before burnishing is composed of: Oil vitriol (sulphuric acid), 2 parts; aqua fortis (nitric acid), 1 part. This solution should be kept in a crock set in a tank of running water, and mixed 7 or 8 hours before using, as the acids when combined heat up. It is best to mix the acids the day before using. In dipping brass, copper and German silver, the parts are strung on a wire whenever possible. If there are no holes in the metal that can be used for stringing, they can be put in a metal or crock basket, but they cannot be handled to good advantage as it is very difficult to thoroughly wash and dip them. After stringing the work on a stiff brass or copper wire, it should be washed in boiling potash, and then dipped in cold water to clean the potash off and cool the metal.

After cooling in the water, they are dipped for a few seconds in the acids, keeping the work constantly in motion, so that the surfaces will be all exposed equally; they are then shaken thoroughly above the acid and immediately washed in two separate cold-water baths, then in hot soap water, and then in hot water, after which they are dryed at once in hot sawdust. This operation will leave a bright, clean surface free from acid.

Common yellow soap, dissolved to thick paste, is used as a lubricant when burnishing brass. The shells and the finger pads are dipped in clear water, and the tool is dipped in the soap paste before burnishing each shell.

A lubricant for copper is made by dissolving about one ounce of ivory or castile soap in a gallon of water. The shells and pads are dipped in this solution, no lubricant being used on the tool. Yellow soap should not be used on copper, as the action of the rosin on copper is different from that on brass, the metal being so glazed or greased that the tool works badly.

For copper plate on steel, such as copperized steel oilers, etc., about one-half ounce oil vitriol to four gallons of water should be used. The burnishing tool should be dipped in a mixture of mutton tallow that has been melted with 5 per cent of beeswax, and the work and the finger pads should be dipped in the acid mixture. The tool is lubricated in the tallow mixture before burnishing each shell.

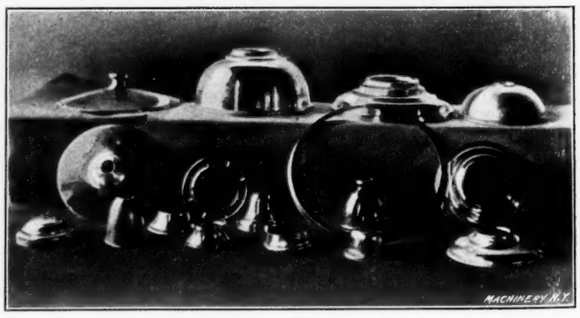


Fig. 5. Samples of Burnished Work

For German silver, the shell should be dipped in clear water, the finger pads in sour beer, and the tool in yellow soap paste.

For white metal or Britannia, use ivory or castile soap in the paste form for the tool, and sour beer or ox gall in water (4 ounces to the gallon) for the finger pads. Wash the work in hot alkali water (a spoonful of cream of tartar, saleratus or soda to a pail of water), and dry in hot sawdust.

For burnished work which is to be lacquered, without coloring on the cloth buff, use thin glue for a lubricant, and also on the finger pads. When the part is burnished put it in saleratus water to keep it from tarnishing; then wash in hot water and dry in hot sawdust. Most plated work can be burnished with the sour beer mixture for the finger pads, and castile or ivory soap paste for the tool lubricant.

THREADING OPERATIONS*—1

PRACTICE FOR THE BROWN & SHARPE AUTOMATIC SCREW MACHINE

By DOUGLAS T. HAMILTON†

The subject of threading on the Brown & Sharpe automatic screw machine forms a very interesting topic for discussion both in regard to the designing of the cams and the setting up of the machine. This is a subject which confuses the beginner on account of the calculations necessary for determining the rise on the cam due to the relation between the speed of the spindle and the driving shaft. The various reversing devices, tripping devices and threading attachments also

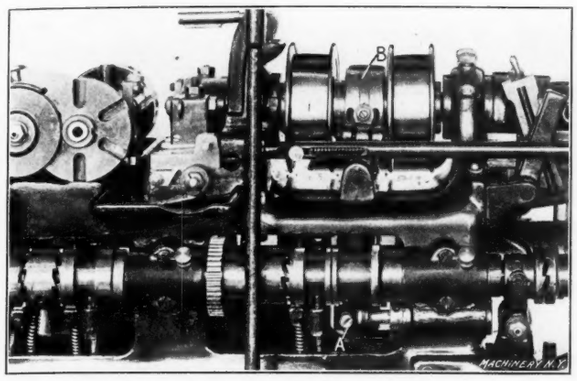


Fig. 1. (Rear View) Number 00 Brown & Sharpe Automatic Screw Machine showing Reversing Mechanism

play an important part in regard to threading. Until the various devices and arrangements used are fully understood, good results cannot be expected. Considering the difficulties encountered, the writer will discuss and illustrate methods and devices for overcoming same.

Reversing the Spindle

On the No. 00 Brown & Sharpe automatic screw machine the spindle is reversed to run backward by means of a spring plunger shown at *A*, Fig. 1; this plunger acting through the medium of the friction clutch *B* reverses the spindle instantaneously. But, to reverse the spindle from backward to forward, onto a slow speed (as is sometimes necessary when cut-

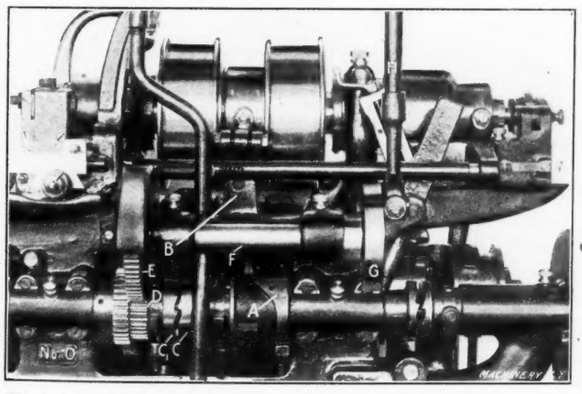


Fig. 2. (Rear View) Number 0 Brown & Sharpe Automatic Screw Machine showing Reversing Mechanism and Belt Shifting Attachment

ting a thread) requires one revolution of the driving shaft, which is equal to 1/120 of the speed at which the spindle is running. For example, let the spindle speed equal 2400 revolutions per minute and the speed of the driving shaft equal 120 revolutions per minute. Then the revolutions required for reversing the spindle $= \frac{2400}{120} = 20$ revolutions. The 20 revolutions used for this purpose is lost time, so to obviate this the Brown & Sharpe Mfg. Co. has provided a speed ratio threading attachment which is used in the turret. This attachment will be described later. On the No. 0 and No. 2 Brown & Sharpe automatic screw machines, the spindle is reversed from forward to backward by means of cam *A* and lever *B*, Fig. 2, which reverses the spindle instantaneously. The spindle is reversed from backward to forward by means of the same cam *A*, situated on the driving shaft, and considering that there are two lobes on this cam, it requires one-half revolution of the driving shaft to reverse the spindle. For example, let the spindle speed equal 1800 revolutions per minute; let the speed of the driving shaft equal 180 revolutions per minute. Then the number of revolutions required to reverse the spindle $= \frac{1800}{180 \times 2} = 5$ revolutions. To reverse the spindle from forward to backward and then forward again (as would be necessary where two threading operations come in succession) requires 4¾ hundredths of the cam surface on account of the tripping dogs on the drum which cannot be placed any closer together. This will be described under the heading "Setting the Tripping Dogs for Threading."

On the No. 2 Brown & Sharpe automatic screw machine, the spindle is reversed in the same manner as on the No. 0, but the ratio between the spindle speed and the driving shaft is different, being 1/240 instead of 1/360 of the speed at which the spindle is running. For example, let the spindle speed equal 1200 revolutions per minute; let the speed of the driving shaft

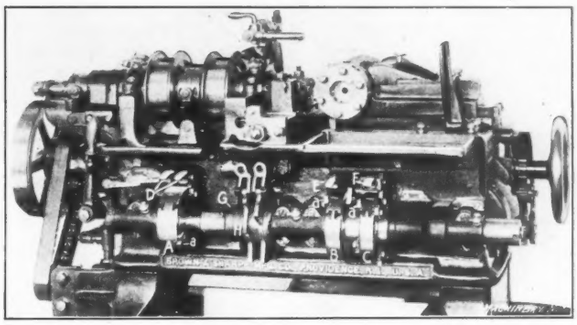


Fig. 3. (Front View) Showing Feeding, Reversing and Revolving Devices

equal 120 revolutions per minute. Then the number of revolutions required to reverse the spindle $= \frac{1200}{120 \times 2} = 5$ revolutions. But to reverse the spindle from forward to backward and forward again (as we explained regarding the No. 0 machine) requires 3¾ hundredths of the cam surface.

Setting the Tripping Dogs for Threading

The tripping dogs *a* which are used for reversing the spindle, feeding the stock, and revolving the turret are placed on the various drums on the front shaft as follows: The dog for reversing the spindle is placed on drum *A*, for feeding

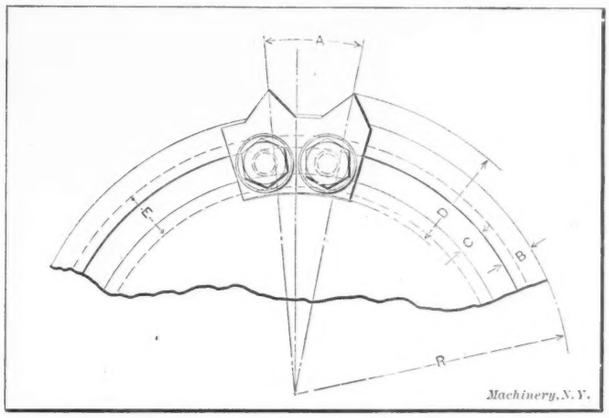


Fig. 4. Reversing Dogs in Position on Drum

the stock on drum *B* and for revolving the turret on drum *C*, as shown in Fig. 3. These dogs operate the levers *D*, *E*, and *F*, respectively, which, in turn, disengage a clutch on the driving shaft on the rear of the machine, thus operating the re-

* For further information on Brown & Sharpe automatic screw machine practice, see "Circular Form and Cut-off Tools," MACHINERY, March and April, 1910, and other articles there referred to.

† Associate Editor of MACHINERY.

versing, feeding and revolving devices. Where two threading operations follow in succession, the time required to revolve the turret is not always sufficient to bring the second tap or die into position. This is illustrated in Fig. 4, where two tripping dogs are shown in position on the drum. To illustrate the method of determining whether extra time should be allowed for clearance, take a practical example. Assume that a set of cams is required to be used on the No. 2 Brown & Sharpe automatic screw machine. Let the spindle speed equal 1200 revolutions per minute; let the time required to complete one piece equal 20 seconds. Then the number of revolutions to complete one piece $= \frac{1200 \times 20}{60} = 400$ revolutions.

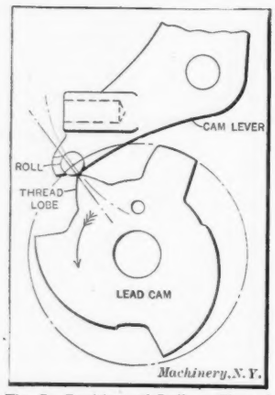


Fig. 5. Position of Roll on Thread Lobe when Spindle is reversed

Referring to the table for laying out cams in the Brown & Sharpe book we find that it requires five hundredths to feed stock, plus one hundredth for clearance. This gives 6 hundredths to revolve the turret. Referring to Table I we find that the angle A is 14 degrees. Then if the number of hundredths of the cam surface utilized in revolving the turret is less than 14 degrees, we would have to add more hundredths for clearance. In this case it requires 6 hundredths to revolve the turret. Then reducing 14 degrees to hundredths $= \frac{100 \times 14}{360} = 3.88$ hundredths. Therefore, it would not be necessary to add extra hundredths in this case.

Setting Dies and Taps

Before the reversing mechanism can operate, the clutch G must engage with clutch H. (See Fig. 3). After engaging these clutches, we set the reversing dog a so that the spindle will reverse just as the roll passes over the highest portion of the thread lobe on the rear cam, as shown exaggerated for clearness in Fig. 5. When the spindle is reversing at the exact point as mentioned, the die or tap holder containing the die or tap is placed in the turret, and brought into position as shown in Fig. 6. The cam roll is set on the thread lobe in the position shown. Here a button die holder A (draw-out type) is shown in position ready to start on the work. The face of the die should be set equal to the distance a, which varies from 1/16 to 3/16 inch, depending on the pitch of the thread and the length of the threaded portion. If the die does not travel on the work far enough at the first setting, the holder can be brought further out of the turret. The same procedure can be followed in setting the tap, except that it should be set more carefully, only going into the work a slight distance in starting, and then moving the holder out of the turret until the desired depth is reached. It is sometimes found necessary after setting the tripping dog, to adjust it slightly,

TABLE I. GENERAL DIMENSIONS OF DRUM AND REVERSING DOGS

No. of Machine	A	B	C	D	E	R
00	20°	$\frac{15}{64}$	$\frac{1}{4}$	$\frac{15}{16}$	$\frac{1}{2}$	2
0	17°	$\frac{5}{16}$	$\frac{1}{4}$	$1\frac{1}{32}$	$\frac{1}{2}$	$2\frac{3}{4}$
2	14°	$\frac{13}{32}$	$\frac{5}{16}$	$1\frac{1}{4}$	$\frac{9}{16}$	$3\frac{1}{4}$

especially when using a draw-out die or tap holder. The turret should not be revolved until the die or tap is clear of the work.

Finding Revolutions for Threading

When calculating the revolutions of the spindle required for threading, a greater number of revolutions should be allowed than the exact number of threads required on the piece, depending on the pitch of the thread (and in some cases on the length of the threaded portion, as when a short thread has to be produced necessitating the threading of a longer portion and then facing it off). This is to allow the die to approach the end of the piece on the rise of the thread lobe. The actual number of revolutions required for threading can be found by the aid of the following formulas:

$$\text{From 14 to 24 pitch } R = \frac{L}{p} + 1.5$$

$$\text{From 28 to 48 pitch } R = \frac{L}{p} + 3 \qquad (1)$$

$$\text{From 56 to 80 pitch } R = \frac{L}{p} + 4.5$$

Where L = length of the threaded portion, p = the pitch of the thread, or $\frac{1}{\text{number of threads per inch}}$, and R equals the revolutions of the spindle required for threading.

Converting Revolutions into Hundredths

Owing to the inconvenience of dividing the cam surface into the same number of equal parts as the revolutions required to complete one piece, the Brown & Sharpe Mfg. Co. has adopted the system of dividing the cam surface into one hundred equal parts, the hundredths being obtained by dividing the number of revolutions for each operation by the total number of revolutions required to complete one piece, taking the nearest decimal with two places. For example, if the number of revolutions required for the die to advance on to the work is 10, and the total number of revolutions required to complete one piece is 200, then $\frac{10}{200} = 0.05$ or 5 one-hundredths of the cam surface.

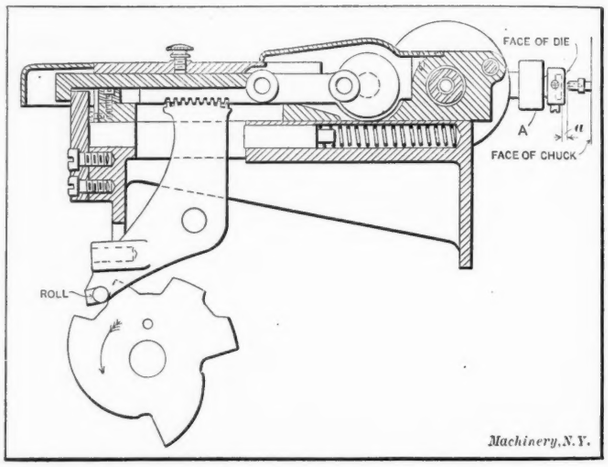


Fig. 6. Position of Roll on Thread Lobe when setting Die or Tap

Constructing the Thread Lobe

The method of laying out the cam lobe as described in the Brown & Sharpe book on the construction of their automatic screw machines, is shown at Fig. 7. The outer circle A indicates the relation between the center of the fulcrum of the lead lever and the cam. This circle represents the path which would be described by the center of the lead lever if it were revolved around the cam. The radius B equals the distance from the center of the roll to the center of the fulcrum on the lead lever. C equals the vertical distance from the center of the cam to the center of the fulcrum on the lead lever, and D equals the horizontal distance. Before constructing the thread lobe, the number of hundredths, the rise on the cam for threading, and the amount that the thread lobe is cut below the outer circle of the cam have to be determined. Then, after having drawn the various circles and lines necessary for the construction, we can proceed as follows: First, from the starting point a, the highest point b and the finishing point c, of the cam lobe, with a radius equal to B describe arcs cutting the outer circle A at the points d, e, and f. Then divide the spaces between the points d, e, and f into the same number of equal spaces as the number of revolutions required

TABLE III. SPINDLE REVOLUTIONS AND CAM RISE FOR THREADING*

Length of Threaded Portion	Number of Threads per Inch: 80	72	64	56	48	40	36	32	30	28	24	20	18	16	14
	First Line: Revolutions of Spindle for Threading Second Line: Rise on Cam for Threading														
$\frac{25}{32}$	67.00	61.00	54.50	48.50	40.50	34.50	31.00	28.00	26.50	25.00	20.50	17.00	15.50	14.00	12.50
	0.754	0.763	0.767	0.779	0.742	0.759	0.758	0.770	0.777	0.786	0.726	0.723	0.732	0.743	0.759
$\frac{13}{16}$	69.50	63.00	56.50	50.00	42.00	35.50	32.50	29.00	27.50	26.00	21.00	18.00	16.00	14.50	13.00
	0.782	0.788	0.795	0.804	0.770	0.781	0.794	0.798	0.807	0.817	0.744	0.765	0.755	0.770	0.789
$\frac{27}{32}$	72.00	65.50	58.50	52.00	43.50	37.00	33.50	30.00	28.50	26.50	22.00	18.50	16.50	15.00	13.50
	0.810	0.819	0.823	0.836	0.797	0.814	0.819	0.825	0.836	0.833	0.779	0.786	0.779	0.797	0.819
$\frac{7}{8}$	74.50	67.50	60.50	53.50	45.00	38.00	34.50	31.00	29.50	27.50	22.50	19.00	17.50	15.50	14.00
	0.838	0.844	0.851	0.860	0.825	0.836	0.843	0.853	0.865	0.864	0.797	0.808	0.826	0.823	0.850
$\frac{29}{32}$	77.00	70.00	62.50	55.50	46.50	39.50	35.50	32.00	30.00	28.50	23.50	19.50	18.00	16.00	14.00
	0.866	0.875	0.879	0.892	0.842	0.869	0.868	0.880	0.880	0.895	0.832	0.829	0.850	0.850	0.850
$\frac{15}{16}$	79.50	72.00	64.50	57.00	48.00	40.50	37.00	33.00	31.00	29.50	24.00	20.50	18.50	16.50	14.50
	0.894	0.900	0.907	0.916	0.880	0.891	0.904	0.908	0.909	0.927	0.850	0.871	0.873	0.876	0.880
$\frac{31}{32}$	82.00	74.50	66.50	59.00	49.50	42.00	38.00	34.00	32.00	30.00	25.00	21.00	19.00	17.00	15.00
	0.923	0.931	0.935	0.948	0.907	0.924	0.929	0.935	0.939	0.943	0.885	0.893	0.897	0.903	0.911
1	84.50	76.50	68.50	60.50	51.00	43.00	39.00	35.00	33.00	31.00	25.50	21.50	19.50	17.50	15.50
	0.951	0.956	0.963	0.972	0.918	0.946	0.953	0.963	0.968	0.974	0.903	0.914	0.920	0.929	0.941
$1\frac{1}{16}$	89.50	81.00	72.50	64.00	54.00	45.50	41.50	37.00	35.00	32.00	27.00	23.00	20.50	18.50	16.50
	1.007	1.013	1.019	1.028	0.990	1.001	1.013	1.018	1.026	1.005	0.956	0.978	0.968	0.982	1.002
$1\frac{1}{8}$	94.50	85.50	76.50	67.50	57.00	48.00	43.50	39.00	37.00	34.50	28.50	24.00	22.00	19.50	17.50
	1.063	1.069	1.076	1.084	1.045	1.056	1.061	1.073	1.084	1.083	1.009	1.020	1.038	1.035	1.062
$1\frac{3}{16}$	99.50	90.00	80.50	71.00	60.00	50.50	46.00	41.00	38.50	36.50	30.00	25.50	23.00	20.50	18.00
	1.119	1.125	1.126	1.141	1.100	1.111	1.122	1.128	1.128	1.146	1.062	1.084	1.086	1.089	1.093
$1\frac{1}{4}$	104.5	94.50	84.50	74.50	63.00	53.00	48.00	43.00	40.50	38.00	31.50	26.50	24.00	21.50	19.00
	1.176	1.181	1.188	1.197	1.155	1.166	1.171	1.183	1.187	1.193	1.115	1.126	1.133	1.142	1.153
$1\frac{5}{16}$		99.00	88.50	78.00	66.00	55.50	50.50	45.00	42.50	40.00	33.00	28.00	25.00	22.50	20.00
		1.238	1.244	1.253	1.210	1.221	1.232	1.238	1.245	1.256	1.168	1.190	1.180	1.195	1.214
$1\frac{3}{8}$		103.5	92.50	81.50	69.00	58.00	52.50	47.00	44.50	41.50	34.50	29.00	26.50	23.50	21.00
		1.294	1.301	1.310	1.265	1.276	1.281	1.293	1.304	1.303	1.211	1.233	1.251	1.248	1.275
$1\frac{7}{16}$			96.50	85.00	72.00	60.50	55.00	49.00	46.00	43.50	36.00	30.50	27.50	24.50	21.50
			1.357	1.366	1.320	1.331	1.342	1.348	1.348	1.366	1.274	1.296	1.298	1.301	1.305
$1\frac{1}{2}$			100.5	88.50	75.00	63.00	57.00	51.00	48.00	45.00	37.50	31.50	28.50	25.50	22.50
			1.413	1.422	1.375	1.386	1.391	1.403	1.406	1.413	1.328	1.339	1.345	1.354	1.366
$1\frac{9}{16}$			104.5	92.00	78.00	65.50	59.50	53.00	50.00	47.00	39.00	33.00	29.50	26.50	23.50
			1.469	1.478	1.430	1.441	1.452	1.458	1.465	1.476	1.381	1.403	1.392	1.407	1.426
$1\frac{5}{8}$				95.50	81.00	68.00	61.50	55.00	52.00	48.50	40.50	34.00	31.00	27.50	24.50
				1.535	1.485	1.496	1.501	1.513	1.524	1.523	1.434	1.445	1.463	1.460	1.487
$1\frac{11}{16}$				99.00	84.00	70.50	64.00	57.00	53.50	50.50	42.00	35.50	32.00	28.50	25.00
				1.591	1.540	1.551	1.562	1.568	1.568	1.586	1.487	1.509	1.510	1.513	1.518
$1\frac{3}{4}$				102.5	87.00	73.00	66.00	59.00	55.50	52.00	43.50	36.50	33.00	29.50	26.00
				1.647	1.595	1.606	1.610	1.623	1.626	1.633	1.540	1.551	1.558	1.566	1.578
$1\frac{13}{16}$				106.0	90.00	75.50	68.50	61.00	57.50	54.00	45.00	38.00	34.00	30.50	27.00
				1.703	1.650	1.661	1.671	1.678	1.685	1.696	1.593	1.615	1.605	1.620	1.639
$1\frac{7}{8}$					93.00	78.00	70.50	63.00	59.50	55.50	46.50	39.00	35.50	31.50	28.00
					1.705	1.716	1.720	1.733	1.743	1.743	1.646	1.658	1.676	1.673	1.700
$1\frac{15}{16}$					96.00	80.50	73.00	65.00	61.00	57.50	48.00	40.50	36.50	32.50	28.50
					1.760	1.771	1.781	1.788	1.787	1.806	1.700	1.721	1.723	1.726	1.730
2					99.00	83.00	75.00	67.00	63.00	59.00	49.50	41.50	37.50	33.50	29.50
					1.815	1.826	1.830	1.843	1.846	1.853	1.752	1.764	1.770	1.779	1.791

TABLE II. SPINDLE REVOLUTIONS AND CAM RISE FOR THREADING*

Length of Threaded Portion	Number of Threads per Inch: 80	72	64	56	48	40	36	32	30	28	24	20	18	16	14
	First Line: Revolutions of Spindle for Threading Second Line: Rise on Cam for Threading														
$\frac{1}{32}$	7.00	7.00	6.50	6.50	4.50	4.50	4.00	4.00	4.00	4.00					
	0.079	0.088	0.091	0.104	0.082	0.099	0.098	0.110	0.117	0.126					
$\frac{1}{16}$	9.50	9.00	8.50	8.00	6.00	5.50	5.50	5.00	5.00	5.00	3.00				
	0.107	0.113	0.120	0.129	0.110	0.121	0.134	0.138	0.147	0.157	0.106				
$\frac{3}{32}$	12.00	11.50	10.50	10.00	7.50	7.00	6.50	6.00	6.00	5.50	4.00	3.50			
	0.135	0.144	0.148	0.161	0.137	0.154	0.159	0.165	0.176	0.173	0.142	0.149			
$\frac{1}{8}$	14.50	13.50	12.50	11.50	9.00	8.00	7.00	7.00	7.00	6.50	4.50	4.00	3.50	3.50	
	0.163	0.169	0.176	0.185	0.165	0.176	0.171	0.193	0.205	0.204	0.159	0.170	0.165	0.186	
$\frac{5}{32}$	17.00	16.00	14.50	13.50	10.50	9.50	8.50	8.00	7.50	7.50	5.50	4.50	4.00	4.00	3.50
	0.191	0.200	0.204	0.217	0.192	0.209	0.208	0.220	0.220	0.236	0.195	0.191	0.189	0.212	0.212
$\frac{3}{16}$	19.50	18.00	16.50	15.00	12.00	10.50	10.00	9.00	8.50	8.50	6.00	5.50	5.00	4.50	4.00
	0.219	0.225	0.232	0.241	0.220	0.231	0.244	0.248	0.249	0.267	0.213	0.234	0.236	0.239	0.243
$\frac{7}{32}$	22.00	20.50	18.50	17.00	13.50	12.00	11.00	10.00	9.50	9.00	7.00	6.00	5.50	5.00	4.50
	0.248	0.256	0.260	0.273	0.247	0.264	0.269	0.275	0.279	0.283	0.248	0.255	0.260	0.266	0.273
$\frac{1}{4}$	24.50	23.50	20.50	18.50	15.00	13.00	12.00	11.00	10.50	10.00	7.50	6.50	6.00	5.50	5.00
	0.276	0.294	0.288	0.297	0.275	0.266	0.293	0.303	0.308	0.314	0.266	0.276	0.283	0.292	0.304
$\frac{9}{32}$	27.00	25.00	22.50	20.50	16.50	14.50	13.00	12.00	11.50	11.00	8.50	7.00	6.50	6.00	5.50
	0.304	0.313	0.316	0.329	0.302	0.319	0.318	0.330	0.337	0.346	0.301	0.298	0.307	0.319	0.334
$\frac{5}{16}$	29.50	27.00	24.50	22.00	18.00	15.50	14.50	13.00	12.50	12.00	9.00	8.00	7.00	6.50	6.00
	0.332	0.338	0.345	0.354	0.340	0.341	0.354	0.358	0.367	0.377	0.319	0.340	0.330	0.345	0.364
$\frac{11}{32}$	32.00	29.50	26.50	24.00	19.50	17.00	15.50	14.00	13.50	12.50	10.00	8.50	7.50	7.00	6.50
	0.360	0.369	0.373	0.386	0.357	0.374	0.379	0.385	0.396	0.393	0.354	0.361	0.354	0.372	0.395
$\frac{3}{8}$	34.50	31.50	28.50	25.50	21.00	18.00	16.50	15.00	14.50	13.50	10.50	9.00	8.50	7.50	7.00
	0.388	0.394	0.401	0.410	0.385	0.396	0.403	0.413	0.425	0.424	0.372	0.383	0.401	0.398	0.425
$\frac{13}{32}$	37.00	34.00	30.50	27.50	22.50	19.50	17.50	16.00	15.00	14.50	11.50	9.50	9.00	8.00	7.00
	0.416	0.425	0.429	0.442	0.412	0.429	0.428	0.440	0.440	0.456	0.407	0.404	0.425	0.425	0.425
$\frac{7}{16}$	39.50	36.00	32.50	29.00	24.00	20.50	19.00	17.00	16.00	15.50	12.00	10.50	9.50	8.50	7.50
	0.444	0.450	0.457	0.466	0.440	0.451	0.464	0.468	0.469	0.487	0.425	0.446	0.448	0.451	0.455
$\frac{15}{32}$	42.00	38.50	34.50	31.00	25.50	22.00	20.00	18.00	17.00	16.00	13.00	11.00	10.50	9.00	8.00
	0.473	0.481	0.484	0.498	0.477	0.484	0.489	0.495	0.499	0.503	0.460	0.468	0.496	0.478	0.486
$\frac{1}{2}$	44.50	40.50	36.50	32.50	27.00	23.00	21.00	19.00	18.00	17.00	13.50	11.50	10.50	9.50	8.50
	0.501	0.506	0.513	0.522	0.495	0.506	0.513	0.523	0.528	0.534	0.478	0.489	0.496	0.504	0.516
$\frac{17}{32}$	47.00	43.00	38.50	34.50	28.50	24.50	22.00	20.00	19.00	18.00	14.50	12.00	11.00	10.00	9.00
	0.529	0.538	0.541	0.554	0.522	0.539	0.538	0.550	0.557	0.566	0.514	0.510	0.519	0.531	0.546
$\frac{9}{16}$	49.50	45.00	40.50	36.00	30.00	25.50	23.50	21.00	20.00	19.00	15.00	13.00	11.50	10.50	9.50
	0.559	0.563	0.570	0.579	0.550	0.561	0.574	0.578	0.587	0.597	0.531	0.553	0.543	0.558	0.577
$\frac{19}{32}$	52.00	47.50	42.50	38.00	31.50	27.00	24.50	22.00	21.00	19.50	16.00	13.50	12.00	11.00	10.00
	0.585	0.594	0.598	0.611	0.577	0.594	0.599	0.605	0.616	0.613	0.567	0.574	0.566	0.584	0.607
$\frac{5}{8}$	54.50	49.50	44.50	39.50	33.00	28.00	25.50	23.00	22.00	20.50	16.50	14.00	13.00	11.50	10.50
	0.613	0.619	0.626	0.635	0.605	0.616	0.623	0.633	0.645	0.644	0.584	0.595	0.614	0.611	0.637
$\frac{21}{32}$	57.00	52.00	46.50	41.50	34.50	29.50	26.50	24.00	23.00	21.50	17.50	14.50	13.50	12.00	10.50
	0.641	0.650	0.654	0.667	0.622	0.649	0.648	0.660	0.675	0.676	0.620	0.616	0.637	0.637	0.637
$\frac{11}{16}$	59.50	54.00	48 50	43.00	36.00	30.50	28.00	25 00	23.50	22.50	18.00	15.50	14.00	12.50	11.00
	0.679	0.675	0.682	0.691	0.660	0.671	0.684	0.688	0.689	0.707	0.638	0.659	0.661	0.664	0.668
$\frac{23}{32}$	62.00	56.50	50.50	45.00	37 50	32.00	29.00	26.00	24 50	23.00	19.00	16.00	14.50	13.00	11.50
	0.698	0.706	0.710	0.723	0.677	0.704	0.709	0.715	0.719	0.723	0.673	0.680	0.684	0.690	0.698
$\frac{3}{4}$	64.50	58.50	52.50	46.50	39.00	33.00	30.00	27.00	25.50	24.00	19.50	16.50	15.00	13.50	12.00
	0.726	0.731	0.738	0.747	0.715	0.726	0.733	0.743	0.748	0.754	0.691	0.701	0.708	0.717	0.728

* In the above tables which contain the pitches as adopted by the A. S.M. E., 22 and 44 threads per inch have been omitted, being rarely used.

for threading. With a radius equal to B and with centers where the divisions cut the large circle A, describe arcs cutting the thread lobe as shown. On the arc cutting the point g, describe the roll circle, this being the position of the cam roll when starting the thread. Then proceed in like manner from the center of this roll, laying off an equal number of spaces corresponding to the pitch of the thread and the number of revolutions required for threading. A series of circles of the diameter of the cam roll, drawn on these centers gives the form of the thread lobe. The form thus produced would not give satisfactory results as crowding of the tap or die would occur owing to the spindle speed and the speed of the driving shaft not being constantly in the same ratio. It is, therefore, advisable to cut down the cam lobe after the first couple of threads. This is shown in Fig. 7 as the actual rise required for threading. As will be seen this is a rather long and difficult method of constructing a cam lobe and can be simplified where a circular milling attachment is available for cutting the cam.

Improved Method of Constructing Thread Lobe

In the method just described the rise on the thread lobe was determined graphically, this being a very complicated and tedious method. The advantage of the following method lies in its simplicity, as the lobe is determined mathematically.

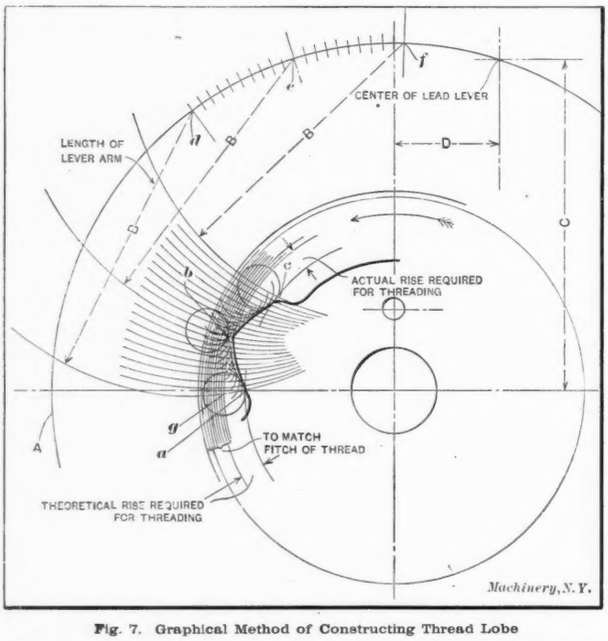

CENTER OF LEAD LEVER
LENGTH OF LEVER ARM
ACTUAL RISE REQUIRED FOR THREADING
TO MATCH PITCH OF THREAD
THEORETICAL RISE REQUIRED FOR THREADING
Machinery, N.Y.

Fig. 7. Graphical Method of Constructing Thread Lobe

Before the thread lobe can be constructed, the length of the threaded portion, the pitch of the thread and the total number of revolutions of the spindle to complete one piece are required. When the number of revolutions for threading and the pitch of the thread are known, the rise on the cam can be found by the following formulas:

$$\begin{aligned} &\text{From 14 to 24 pitch, } r = R \times p \times 0.85, \\ &\text{From 28 to 48 pitch, } r = R \times p \times 0.88, \\ &\text{From 56 to 80 pitch, } r = R \times p \times 0.90. \end{aligned} \qquad (2)$$

Where R equals the revolutions required for threading, p equals pitch of thread, or $\dfrac{1}{\text{number of threads per inch}}$, r equals rise on cam.

In Tables II and III the results as obtained by formulas (1) and (2) for the various pitches are tabulated. To show the advantages of these tables, take a practical example. Assume that a set of cams is required for the No. 00 Brown & Sharpe automatic screw machine. To make the piece as shown at A, Fig. 8, let the spindle speed equal 2400 revolutions per minute, the number of revolutions to complete one piece, 400, time to make one piece, 10 seconds. Referring to A, Fig. 8, the length of the threaded portion is $\frac{3}{8}$ inch and the pitch of the thread 1/32 inch, or thirty-two threads per inch. Referring to Table II, we find that the number of revolutions required is 15 and the rise on the cam 0.413. To construct the lobe, convert the revolutions into hundredths, or $\frac{15}{400} = 0.0375$ or $3\frac{3}{4}$ hundredths. Then draw the cam circle B, as shown in Fig. 8, and lay off on this circle $3\frac{3}{4}$ hundredths to advance on the screw and $3\frac{3}{4}$ hundredths to withdraw. Cut down the amount C below the outer cam circle B as required. Bisect the rise at E and with OE as a radius and a, b, and c as centers draw arcs intersecting each other at d and e. With d as a center and a radius OE, join the points b and a; with e as a center and radius OE join points c and a. This gives the shape of the thread lobe. For convenience in cutting, when a Brown & Sharpe circular milling attachment is available, the cam surface used by the tools is divided into minutes. Then to obtain the lead (or the number of minutes traversed for each 1/1000 inch rise) divide the number of minutes contained in that portion of the lobe used, by the rise. For example, $\frac{810}{0.413} = 1.96$, or approximately 2 minutes. The equivalents of hundredths and minutes are tabulated in Tables IV and V. The information as derived by the various formulas is recorded on the drawing as shown in Fig. 8, being used by the toolmaker when cutting the cam.

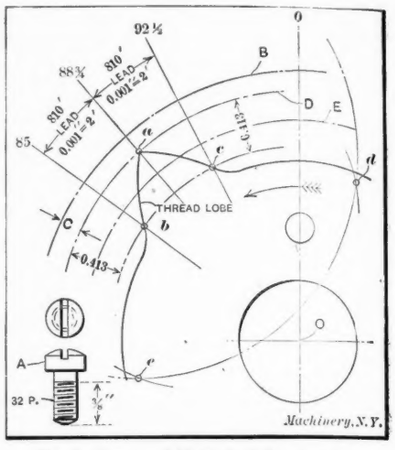


Fig 8. Improved Method of Constructing Thread Lobe

Speed-changing Device

When threading brass, the spindle speed used for the other tools is generally suitable for taps and dies, but when threading gun-screw iron, Norway iron, machine steel, tool steel, etc., the speed used is too high. As has been previously explained under the heading "Reversing the Spindle," time would be lost in threading if the machine were reversed from forward to backward and then forward again (on the No. 00 Brown & Sharpe automatic screw machine). There are various methods of overcoming this difficulty, some of which are as follows:

One method of accomplishing this for the forming and cut-off operations is to run the spindle backward with the large

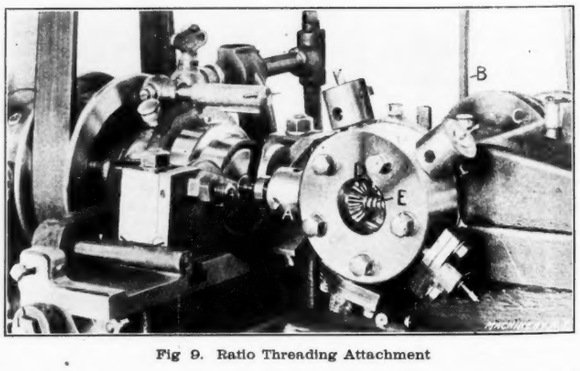


Fig 9. Ratio Threading Attachment

pulley and forward with the small pulley on the countershaft. There is an objection to this, however, *viz.*, as there are generally other tools in the turret besides the die or tap holder, they would either have to be made to cut left-hand or else run at the same speed as the tap or die. It can easily be seen that in the majority of cases, the tools used in the turret would not be working at their maximum capacity if made to cut right-hand.

TABLE IV. HUNDREDTHS OF CIRCUMFERENCE EXPRESSED IN MINUTES

Hundredths of Circumference	Minutes	Hundredths of Circumference	Minutes	Hundredths of Circumference	Minutes	Hundredths of Circumference	Minutes	Hundredths of Circumference	Minutes	Hundredths of Circumference	Minutes
1.00	216	9.25	1998	17.50	3780	25.75	5562	34.00	7344	42.25	9126
1.25	270	9.50	2052	17.75	3834	26.00	5616	34.25	7398	42.50	9180
1.50	324	9.75	2106	18.00	3888	26.25	5670	34.50	7452	42.75	9234
1.75	378	10.00	2160	18.25	3942	26.50	5724	34.75	7506	43.00	9288
2.00	432	10.25	2214	18.50	3996	26.75	5778	35.00	7560	43.25	9342
2.25	486	10.50	2268	18.75	4050	27.00	5832	35.25	7614	43.50	9396
2.50	540	10.75	2322	19.00	4104	27.25	5886	35.50	7668	43.75	9450
2.75	594	11.00	2376	19.25	4158	27.50	5940	35.75	7722	44.00	9504
3.00	648	11.25	2430	19.50	4212	27.75	5994	36.00	7776	44.25	9558
3.25	702	11.50	2484	19.75	4266	28.00	6048	36.25	7830	44.50	9612
3.50	756	11.75	2538	20.00	4320	28.25	6102	36.50	7884	44.75	9666
3.75	810	12.00	2592	20.25	4374	28.50	6156	36.75	7938	45.00	9720
4.00	864	12.25	2646	20.50	4428	28.75	6210	37.00	7992	45.25	9774
4.25	918	12.50	2700	20.75	4482	29.00	6264	37.25	8046	45.50	9828
4.50	972	12.75	2754	21.00	4536	29.25	6318	37.50	8100	45.75	9882
4.75	1026	13.00	2808	21.25	4590	29.50	6372	37.75	8154	46.00	9936
5.00	1080	13.25	2862	21.50	4644	29.75	6426	38.00	8208	46.25	9990
5.25	1134	13.50	2916	21.75	4698	30.00	6480	38.25	8262	46.50	10044
5.50	1188	13.75	2970	22.00	4752	30.25	6534	38.50	8316	46.75	10098
5.75	1242	14.00	3024	22.25	4806	30.50	6588	38.75	8370	47.00	10152
6.00	1296	14.25	3078	22.50	4860	30.75	6642	39.00	8424	47.25	10206
6.25	1350	14.50	3132	22.75	4914	31.00	6696	39.25	8478	47.50	10260
6.50	1404	14.75	3186	23.00	4968	31.25	6750	39.50	8532	47.75	10314
6.75	1458	15.00	3240	23.25	5022	31.50	6804	39.75	8586	48.00	10368
7.00	1512	15.25	3294	23.50	5076	31.75	6858	40.00	8640	48.25	10422
7.25	1566	15.50	3348	23.75	5130	32.00	6912	40.25	8694	48.50	10476
7.50	1620	15.75	3402	24.00	5184	32.25	6966	40.50	8748	48.75	10530
7.75	1674	16.00	3456	24.25	5238	32.50	7020	40.75	8802	49.00	10584
8.00	1728	16.25	3510	24.50	5292	32.75	7074	41.00	8856	49.25	10638
8.25	1782	16.50	3564	24.75	5346	33.00	7128	41.25	8910	49.50	10692
8.50	1836	16.75	3618	25.00	5400	33.25	7182	41.50	8964	49.75	10746
8.75	1890	17.00	3672	25.25	5454	33.50	7236	41.75	9018	50.00	10800
9.00	1944	17.25	3726	25.50	5508	33.75	7290	42.00	9072	50.25	10854

TABLE V. HUNDREDTHS OF CIRCUMFERENCE EXPRESSED IN MINUTES

Hundredths of Circumference	Minutes	Hundredths of Circumference	Minutes	Hundredths of Circumference	Minutes	Hundredths of Circumference	Minutes	Hundredths of Circumference	Minutes	Hundredths of Circumference	Minutes
50.50	10908	59.00	12744	67.50	14580	76.00	16416	84.50	18252	93.00	20088
50.75	10962	59.25	12798	67.75	14634	76.25	16470	84.75	18306	93.25	20142
51.00	11016	59.50	12852	68.00	14688	76.50	16524	85.00	18360	93.50	20196
51.25	11070	59.75	12906	68.25	14742	76.75	16578	85.25	18414	93.75	20250
51.50	11124	60.00	12960	68.50	14796	77.00	16632	85.50	18468	94.00	20304
51.75	11178	60.25	13014	68.75	14850	77.25	16686	85.75	18522	94.25	20358
52.00	11232	60.50	13068	69.00	14904	77.50	16740	86.00	18576	94.50	20412
52.25	11286	60.75	13122	69.25	14958	77.75	16794	86.25	18630	94.75	20466
52.50	11340	61.00	13176	69.50	15012	78.00	16848	86.50	18684	95.00	20520
52.75	11394	61.25	13230	69.75	15066	78.25	16902	86.75	18738	95.25	20574
53.00	11448	61.50	13284	70.00	15120	78.50	16956	87.00	18792	95.50	20628
53.25	11502	61.75	13338	70.25	15174	78.75	17010	87.25	18846	95.75	20682
53.50	11556	62.00	13392	70.50	15228	79.00	17064	87.50	18900	96.00	20736
53.75	11610	62.25	13446	70.75	15282	79.25	17118	87.75	18954	96.25	20790
54.00	11664	62.50	13500	71.00	15336	79.50	17172	88.00	19008	96.50	20844
54.25	11718	62.75	13554	71.25	15390	79.75	17226	88.25	19062	96.75	20898
54.50	11772	63.00	13608	71.50	15444	80.00	17280	88.50	19116	97.00	20952
54.75	11826	63.25	13662	71.75	15498	80.25	17334	88.75	19170	97.25	21006
55.00	11880	63.50	13716	72.00	15552	80.50	17388	89.00	19224	97.50	21060
55.25	11934	63.75	13770	72.25	15606	80.75	17442	89.25	19278	97.75	21114
55.50	11988	64.00	13824	72.50	15660	81.00	17496	89.50	19332	98.00	21168
55.75	12042	64.25	13878	72.75	15714	81.25	17550	89.75	19386	98.25	21222
56.00	12096	64.50	13932	73.00	15768	81.50	17604	90.00	19440	98.50	21276
56.25	12150	64.75	13986	73.25	15822	81.75	17658	90.25	19494	98.75	21330
56.50	12204	65.00	14040	73.50	15876	82.00	17712	90.50	19548	99.00	21384
56.75	12258	65.25	14094	73.75	15930	82.25	17766	90.75	19602	99.25	21438
57.00	12312	65.50	14148	74.00	15984	82.50	17820	91.00	19656	99.50	21492
57.25	12366	65.75	14202	74.25	16038	82.75	17874	91.25	19710	99.75	21546
57.50	12420	66.00	14256	74.50	16092	83.00	17928	91.50	19764	100.00	21600
57.75	12474	66.25	14310	74.75	16146	83.25	17982	91.75	19818	.....	.....
58.00	12528	66.50	14364	75.00	16200	83.50	18036	92.00	19872	.....	.....
58.25	12582	66.75	14418	75.25	16254	83.75	18090	92.25	19926	.....	.....
58.50	12636	67.00	14472	75.50	16308	84.00	18144	92.50	19980	.....	.....
58.75	12690	67.25	14526	75.75	16362	84.25	18198	92.75	20034	.....	.....

Ratio Threading Attachment

The attachment *A*, shown in position in the turret in Fig. 9, serves to revolve the die or tap in the same direction as that in which the spindle is rotating, but at one-half the spindle speed. As before mentioned, it is used where no other slow movements are required except for threading, enabling the spindle to run at its maximum speed for all the other operations. The attachment is driven by a ⅜-inch round belt from the overhead works, the shaft passing through the turret head connecting pulley *C* with bevel gears *D*, thus driving the attachment *A*. The spring *E* acts in the same manner as the spring in the ordinary draw-out die or tap holder. The method of determining the shape of the cam lobe when using this attachment is as follows: Let the spindle speed for the forming and cut-off operations equal 2400 revolutions per minute, then the speed of this attachment will be 600 revolutions per minute. Assume the length of the threaded portion to be 3/16 inch and the thread 40 pitch. Referring to Table II, we find that it will require 10.5 revolutions. But considering that the speed of this attachment is one-half

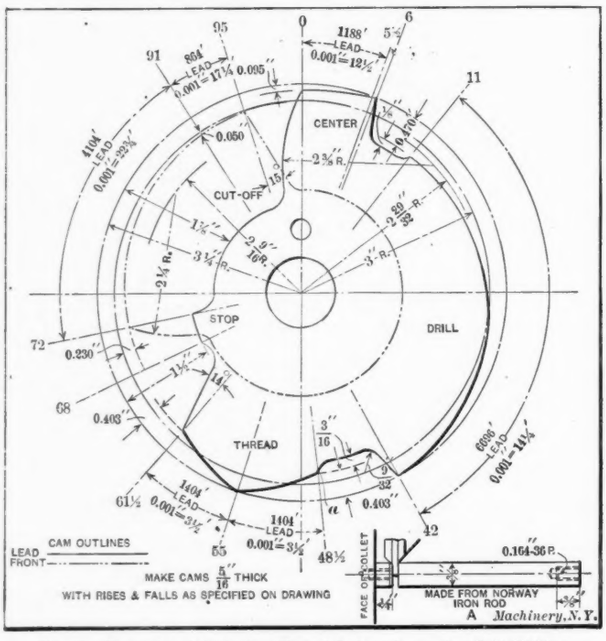


Fig. 10. Example of designing Thread Lobe when using Belt Shifting Attachment

the spindle speed, we would require $10.5 \times 2 = 21$ revolutions for cutting the thread. Again, as this attachment rotates in the same direction as the spindle, the speed of the attachment when backing off the work would be 2400 + 600 or 3000 revolutions per minute. Then the number of revolutions required for backing off the work would be $\frac{2400}{3000} \times 10.5$, or 8.5 revolutions approximately. The same rise, 0.231, as given in Table II is used for each side of the thread lobe, but the number of hundredths contained in each part of the lobe is different, as it requires 21 revolutions to advance and only 8.5 revolutions to retreat.

Belt Shifting Attachment

The ratio threading attachment as shown in Fig. 9 is only suitable for cutting brass and fine threads on Norway iron, machine steel, etc. This attachment would not be entirely satisfactory for the No. 0 or No. 2 Brown & Sharpe automatic screw machine, as a more positive drive is generally required for these machines. In Fig. 2 is shown the No. 0 Brown & Sharpe automatic screw machine equipped with this speed-changing attachment. The countershaft is supplied with a large and a small pulley which will give the desired spindle speeds. This attachment is operated by the same dog and lever that reverses the spindle. When the dog on the cam shaft trips the lever, the clutches *C* and C_1 engage, thus driving gears *D* and *E*. The gear *E* being attached to shaft *F* revolves the disk *G* on which the eccentric connecting-rod *H* is attached. When the rod *H* is drawn up or down it shifts the belt from the large to the small pulley or *vice versa*. The system of gearing provided shifts the belt twice for every revolution of the driving shaft. Therefore, the number of revolutions required for changing the speed when the spindle is running at 1800 and 900 revolutions respectively would be as follows: When the spindle is running at 1800 revolutions per minute it would require $\frac{1800}{180 \times 2} = 5$ revolutions, but it is obvious that part of the time the spindle will be running at 900 revolutions per minute. Then the number of revolutions required to shift the belt when the spindle is running at 900 revolutions per minute $= \frac{900 \times 2}{180}$ = 10 revolutions. Therefore, the actual number of revolutions required to shift the belt would be $\frac{10 + 5}{2} = 7\frac{1}{2}$ revolutions.

To explain thoroughly the method of designing the thread lobe, we will take a practical example. Assume that it is required to make the piece as shown at *A*, Fig. 10, the spindle speed being 1800 and 900 revolutions per minute respectively (using the 900 revolutions per minute for tapping). The cams for making this piece are shown in Fig. 10. The time required to make one piece being 17 seconds, or 510 revolutions, then the number of revolutions for threading found in Table II is 16.5; but as the tap will run at 900 revolutions per minute instead of 1800, we will require 16.5×2 or 33 revolutions for threading. Then the hundredths required equals $\frac{33}{510} = 0.0647$, or approximately 6½, the rise on the cam being the same as that in Table II, 0.403. Referring to the table in the Brown & Sharpe book, we find that it will require 4/100 to feed the stock + 1 = 5/100 to revolve the turret; this equals 25.5 revolutions to revolve the turret. Then the actual number of hundredths between the last operation and the starting of the thread lobe to revolve the turret and reverse the spindle is $25.5 + 7.5 = 33$ revolutions. Converting this into hundredths, we get 6.47 or approximately 6½ hundredths. It is always good practice to allow plenty of clearance for threading, as the die or tap holder intended for the job may have to be replaced by one which would require more clearance.

* * *

In a note recently published in MACHINERY (see the January, 1909, and November, 1905, issues), attention was called to the limitations of sewing machine capacity. It was stated that the heating of the needle in thick goods prevents the needle exceeding a certain number of strokes per minute. On ordinary thin goods such as muslin the strength of the thread is the limitation of the capacity, however. If the cotton thread used on the average run of manufactured goods were of a higher tensile strength, the machines could be run faster. The Wilcox & Gibbs manufacturing machines are tested at about 3825 stitches per minute, and the common speed in use is somewhat less. The tests are made on a circular band of muslin which encircles the bench on which the machine is supported. The band of cloth is driven around and around over and under the bench at a speed amazing to one accustomed only to the work of the domestic sewing machine. If a stitch is 1/16 inch long the speed at 3825 stitches per minute is 239 inches per minute, or nearly 20 feet.

* * *

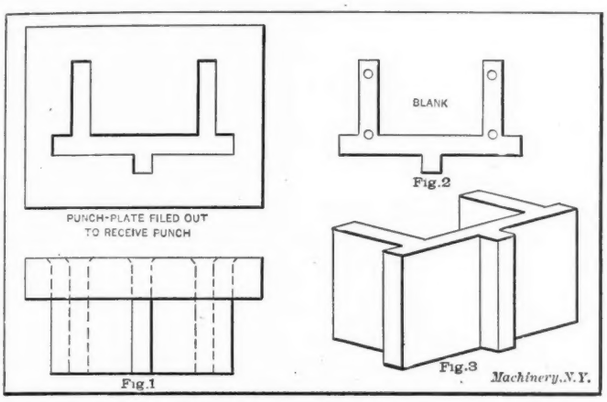
What is the limit of human endurance in handling parts? The answer depends on the shape, weight, and the distance that they have to be moved. Of a certain class of work, consisting of light objects, boys handle an average of one piece a second all day long, or 36,000 in ten hours. The object has to be picked up and mounted on a series of moving pins, the holes in the objects being comparatively small. Boys learn to do the work with ease and do not complain of weariness, but on the contrary seem light-hearted and cheerful. So expert do they become that the work is performed automatically—without thought—the operators being able to converse, laugh, joke and sing at their work. Curiously enough, if they stop to think what they are doing, they bungle and fall behind.

OUT-OF-DATE DIE-MAKING METHODS

By F. E. SHAILOR*

It seems as if die making has been known long enough for everyone engaged in sheet metal work to have found out the best methods and to use the best, instead of clinging to the original ideas such as filing out the punch holder to exactly fit the punch, making a large die (having many piercing dies in it) solid, and many other methods that have proved to be a source of trouble, extra expense for maintenance, etc. The following suggestions will be put in the form of comparisons and the reader can judge for himself which are the better:

First, let us take up various methods of forming the punch, and of securing it to the punch-plate. If we were to explore the junk boxes in the cellars of some of our best and oldest factories in which punches and dies are used, we would be very likely to find punches made as shown in Fig. 1, but long since discarded. Let us assume that we are about to make a punch and die to produce the blank shown in Fig. 2. The



Figs. 1, 2 and 3. Objectionable Method of Attaching Punch to Plate

method in vogue fifty years ago and still used by some large up-to-date (?) factories, is to machine the entire length of the punch as shown in Fig. 3. The punch-plate is then drilled and filed to fit the punch as tightly as possible and the back of the punch is upset as shown to prevent it from pulling out. Every die maker knows that it is "no cinch" to file out a die so that a templet fits absolutely even, though we have the advantage of the clearance in the die which makes it possible to enter the templet before the die is filed to size. This is not

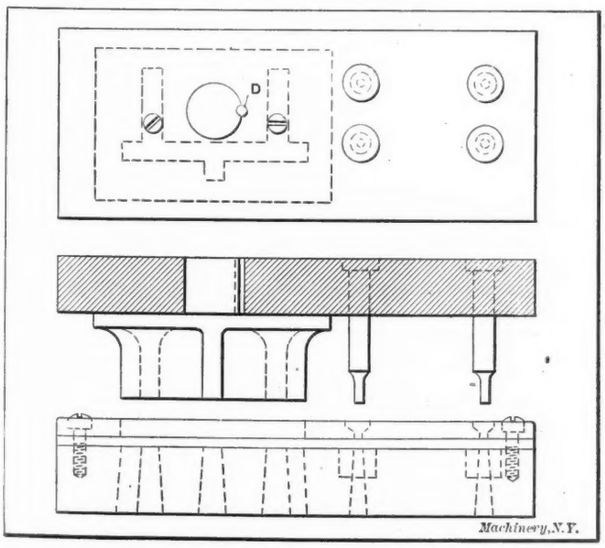


Fig. 4. Punch Attached to Die so as to obtain Greater Rigidity and Durability

the case, however, with the punch-plate shown in Fig. 1; this must be filed absolutely straight in order to secure a good fit.

The greatest objections to making a punch and punch-plate in this manner are the weakening of the punch and the difficulty experienced in making the fit good enough to rigidly hold the punch. We know that a plug and ring gage will "shake" if there is a difference of 0.0001 inch; can we expect to file perfectly straight and within one-tenth of a thousandth? After a greater length of time has been spent making the punch-plate than was necessary for making the die, we find we are obliged to peen the punch-plate in order to have it fit the

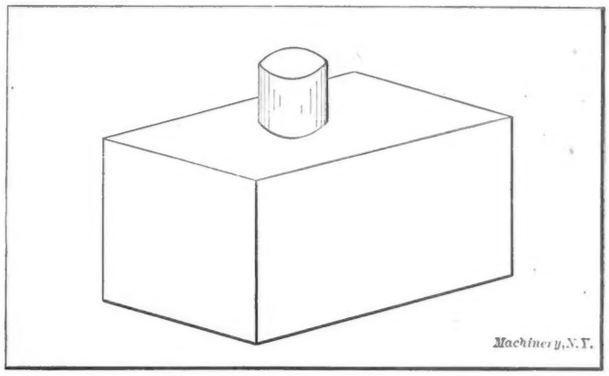


Fig. 5. First Step in Making Punch shown in Fig. 4

punch tightly. Then after the press operator makes one miscut, or a "half cut," the punch which is not sufficiently rigid, springs to one side, shears, loosens the peening effect, which causes the punch to "shake" in the punch-plate and this continues to cause trouble until the die is worn out.

Again, fitting the punch in the plate, necessitates fitting the entire length in the die, in order to allow the plate to come in contact with the die so that the holes for the piercing punches can be transferred from the die with some degree of accuracy. This latter method is a poor way to transfer, first because the piercing dies have clearance and the smallest diameter is in

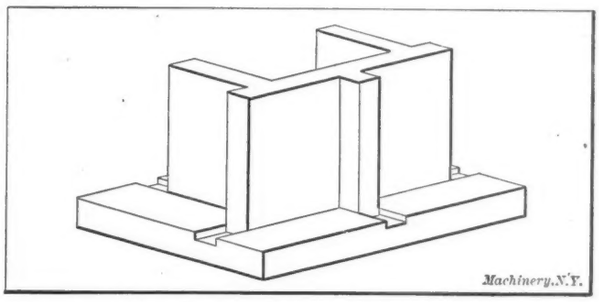


Fig. 6. Another Objectionable Method of attaching Punch to Plate

contact with the punch-plate so that whatever is used to transfer does not, of course, fit the dies. On the other hand, if the punch-plate is away from the die there are chances of error in transferring, one chance being in the truth of the parallels used and another and greater in the taper hole which is being used to guide a straight transfer point.

The style of dies referred to in the foregoing can be found in the cellar of the New Haven Clock Co. with forty years of rust thereon. Messrs. Thomas N. Gierding and T. Grady of the New Haven Clock Co. have done considerable toward bringing die making out of its infancy, as it were, for which they deserve due credit. The writer has seen in numerous shops types of dies and methods of making them that originated with these men.

An improved method of holding a punch is shown in Fig. 4. The way this punch and die is made will be described, so that the reader can judge which is the more practical, easier to make, and more durable. As there are piercing punches and dies, the punch-plate, stripper, and die would be doweled together, laid out, indicated, and the holes for the piercing punches drilled and bored, assuming, of course, that the die has been filed out for the blanking punch. The outline of the hole in the die for the blanking punch is then transferred to the punch-plate (a lead pencil is good enough for this purpose). A point approximately in the center of this outline is found, marked and indicated approximately true, drilled and bored, and at the same setting a light cut is taken to insure a perfect seat for the punch. The latter is turned up as shown

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in Fig. 5. The piercing punches are left 1/16 inch longer than the blanking punch so that the outline of the die may be accurately transferred to the punch. A dowel pin hole *D* is drilled and reamed in the shank and plate so that it will be possible to place the punch back in the same position after removing it. After the punch is milled to the scribed outline, the edge is slightly beveled. The punch is then returned to its seat in the plate and the piercing punches are entered and used as a guide to shear the blanking punch. It will be seen that the lead pencil was good enough for transferring the outline as the punch is guided entirely by the piercing punches when being sheared. Compare the simple and efficient method

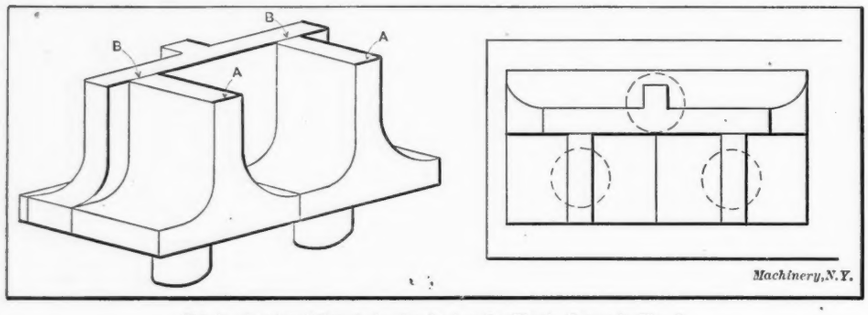

Fig. 7. Sectional Punch for Producing the Blank shown in Fig. 2

of securing the punch to the plate illustrated in Fig. 4 with that shown in Fig. 1; note in the former the rigidity of the punch, the absence of the possibility of springing on a "half cut," the strength of the punch-plate, and the reduced chances of the punch springing out of shape when being hardened. The method illustrated in Fig. 4 is the best that has come under the writer's experience of sixteen years for easily making a rigid, altogether satisfactory punch and die. If any reader knows of a better method we would all like to know of it, and I, for one, will adopt it.

Fig. 6 shows another method of making punches and securing them to the holder, which has several bad features: First, there is not sufficient seat. Imagine a punch one inch long by one-half inch wide, made in this way. A movement of 0.001 inch at the seat means enough at the cutting edge to cause it to shear. Then after the punch is hardened, will it fit the recess planed for it? Not much! But if it had a wide seat or flange, even though it was merely set on the plate, it would be far better as the flange helps wonderfully towards holding the punch in shape when hardening. A good way to make the punch shown in Fig. 1 is to make it in parts, as in Fig. 7. If the punches spring open or together, we have a means of bringing the ends back by rotating them about the shank. In this way quite a movement can take place at points *A* and what little the punch opens at *B* will not materially affect the cutting action.

Oftentimes the die to be made is, say, eight inches long and

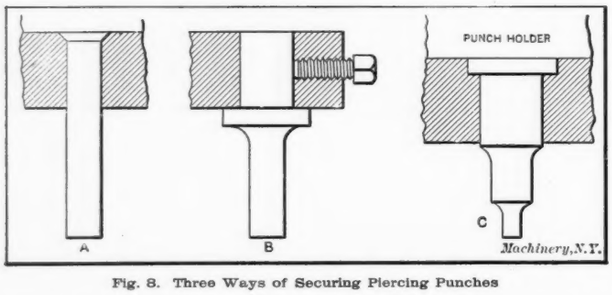

Fig. 8. Three Ways of Securing Piercing Punches

contains several piercing dies besides the blanking die. The writer has made such dies solid, but finds it better practice to make the die in halves, the blanking die being made of tool steel and the part containing the piercing dies of machine steel with tool steel bushings. It is much easier to harden a small die without perceptibly changing its shape than it is one eight inches long; besides, if the piercing dies demand accuracy between the centers, it is necessary to grind the holes after hardening, with a solid die, whereas with one having a soft machine steel block, changes in the center distances of the holes are eliminated. Another good feature of the sectional die is that if some change is made after the die is complete, whereby a smaller or larger hole is needed, a new bushing can easily be inserted; but not so if the die is solid and of tool steel, hardened. This same scheme can be employed on the punch-plate. [A die built on the plan referred to in the foregoing, is shown in Fig. 10. As the illustration shows, the piercing dies are independent of the blanking die, being in the form of bushings. This engraving was taken from one of the advertisements of the Firth-Sterling Steel Co.—EDITOR.]

The writer has found it good practice always to bore the punch-plate, stripper, and die together, when possible to do so. Some die makers insert the blanking punch as far as possible in the die, put parallels between the plate and die, and then, with a twist drill, "soak" the holes into the plate from the die. After the piercing punches are in the plate, they are knocked this way and that to line them up; but suppose those piercing punches were 1 inch in diameter or even 5/8 inch; such sizes are not knocked around so easily and this is a poor job at best. Peening is resorted to on punches that do not move easily; that is, the stock near the punches is indented with a blunt cold chisel, sufficiently to cause it to "flow" and force the punch over. But only a very few strokes in the press are

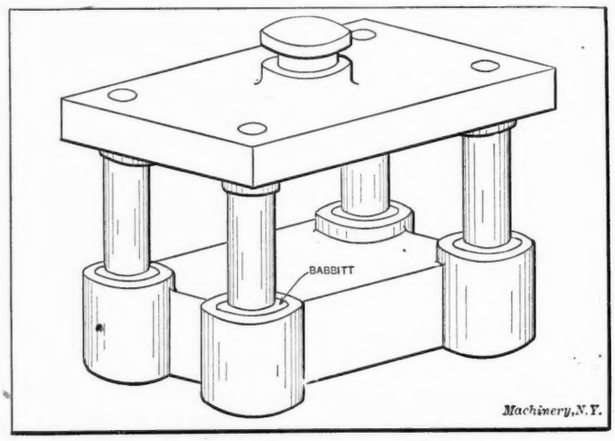

Fig. 9. Die with Guide Posts inserted in Babbitt Bearings

necessary to cause the stock to flow back again, and then there is a sheared punch, and a burr on the work. The die is then taken out and the stock peened again just to make the punch line up until it is off the maker's hands. A few dollars extra, expended in properly making the die, is a mighty good investment. The first cost of a die may be low, but it does not necessarily mean that it is a cheap die; it is a mighty expensive one in the long run, and a toolmaker that will knock punches, peen the punch-plate, or other "after-me-the-deluge" methods, ought not to be classed as a toolmaker—he's a "butcher" and should be treated as such.

The method of securing piercing punches varies in different shops. Some make a straight punch as at *A*, Fig. 8, and hold it in the plate by riveting; others make it as at *B* and secure it to the plate by means of a set-screw on the side; but the ideal method is shown at *C*. This punch has an excellent seat, it is easy to make, cannot be pulled out and is reinforced to eliminate all spring as far as possible. If this is the ideal method of making piercing punches, why is it that supposedly modern shops cling to set-screws that tend to displace the punch, to riveting the head, and to making punches the same size the entire length—the weakest construction of all.

When making dies having guide posts, as in Fig. 9, which shows a sort of sub-press construction, it is almost universally customary to bore the holes to fit the guide-pins. It is a long,

expensive, and difficult job to bore four one-inch holes in the top plate and four one-inch holes in the bottom plate and have the four pins line up with and travel freely in the holes. I have found it good practice to bore the holes in the plate to hold the pins, but the holes in which the pins are to travel can be drilled say ¼ inch large and anywhere within 1/16-inch of the correct location. The punch is then entered into the die (the pins being first treated to a light coating of graphite and oil) and the holes are babbitted. This method insures absolute alignment, the work is easily done and no great attention need be paid to center distances or to the diameter of the

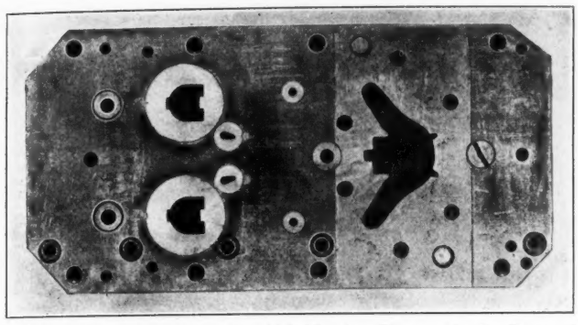

Fig. 10. Die Construction in which Piercing Dies are in the Form of Bushings and Independent of the Blanking Die—Taken from one of the Advertisements of the Firth-Sterling Steel Co

holes. When bored holes are employed, it means absolute accuracy between the centers of the top and bottom plate; it means that the holes must be bored to fit exactly the pins which travel in them, as otherwise the die will shear; it means a lot of unnecessary work on the part of a skilled mechanic, because four one-inch pins will not spring here and there just to be accommodating, and, besides, the fit obtained by boring must of necessity be a trifle free in order to work easily when shearing the punches. With babbitted holes, however, the fit is excellent but it is not made until after the punch and die are entered, and the press can take care of a tight fit or, rather, perfect alignment.

* * *

"DON'TS" FOR PLANER MEN

By DONALD A. HAMPSON*

Don't cut into parallels.

Don't run a planer with a loose rack.

Don't put greasy fingers on finished work.

Don't brush dirt off the table into the ways.

Don't forget that a little grease is good for gears.

Don't let chips accumulate around the bull wheel.

Don't use a finger-clamp when a U-clamp can be applied.

Don't finish a piece of cast iron with anything but a broad flat tool.

Don't try to cut a keyway in a shaft without some positive stop for it.

Don't stick wrenches, tools, or hammers in the post holes in the table.

Don't try to true up the top of a badly worn planer table with just one cut.

Don't tighten on a clamp unless the bolt enters the nut for its full thickness.

Don't forget to bevel slightly both ends of a casting before taking a finish cut.

Don't leave a rough surface when that surface has to be used later to line up by.

Don't "clear a space" to put on a new job; a live man never has a littered-up planer.

Don't consider a job of angular cutting completed until you have set the head back to "zero."

Don't forget that an occasional drop of oil on bolts and nuts prolongs their life considerably.

Don't take a long "wind chip" because you are too lazy to set the dogs up for the short cuts at each end.

Don't forget that a spring tool, or a modified form of one, is best to finish a cast iron surface accurately.

Don't clean out T-slots without first running the table out so that no chips can fall into the oil drip cups.

Don't put a clamp on a piece of finished work without a piece of heavy paper between the clamp and work.

Don't tighten a chuck so that a light piece is distorted and expect the planed surface to be true when taken out.

Don't set a tool to a height gage for any but the very lightest cuts, without allowing for the spring of the tool.

Don't neglect a belt that shows signs of coming apart; if you do you may get an ugly cut from it when it gives way.

Don't do all or half of your short work in the middle of the planer; let the wear be distributed to the ends as well.

Don't fail to look under the cross-rail and saddle for drops of oil and to wipe them off before finishing a cast iron surface.

Don't trust to the base and jaws of a chuck to make your work parallel and square unless you *know* that the chuck is right.

Don't throw away good wooden wedges and blocks; you can never tell how soon the same job will come up again and you may need them.

Don't do any unnecessary hammering on the planer; if clearances have to be cut, do that before placing the work on the machine.

Don't use any but a solid wrench, and one that fits, to set dogs; an adjustable one makes rounded nuts and may prove dangerous as well.

Don't work one head on a job simply because "it wouldn't pay to set the other head for just one piece"; do a little hustling and make it pay.

Don't fail to put bolts as near the work as possible, and in any case give yourself the benefit of 2 to 1 leverage when setting bolts, clamps and packing.

Don't stop the table by half shifting the belts without locking the shifting mechanism; many a man has been maimed by neglecting to do this.

Don't think that the elevating screws and their bearings never need oil; the top of the arch is too often thick with dust and the bearings completely dry.

Don't let the rear oil pockets fill up with chips, blocks and tools; the chips jar out on the ways and the tools may fall inside and "short circuit" the stroke.

Don't fail to try the ways of a planer at least once a year; no matter how carefully the machine may have been set, settling of the floor or foundation may have occurred.

Don't start a side cut downward without first making sure that all interferences in the way of work or bolts are below the plane of the head at the bottom of the cut.

Don't lubricate the cross-rail of your machine with a squirt can; saturate a piece of clean waste and oil with this; a film of oil on the sides is better than many drops on the table or work.

Don't pass a job lined up with the cross-rail as being square without proving it, unless the cross-rail and housings have been tested and found correct, within a reasonable length of time.

Don't be too particular about packing up a rough job, but remember that on a "perfect" one the minutes spent in shimming up and papering will save the hours that would have to be spent in fitting or recutting.

Don't forget that a box containing short lengths of drawn steel makes a valuable and handy set of gages for the planer; have, if possible, all sizes, by sixteenths, up to one inch, and larger sizes varying by one inch.

Don't forget that a man with an indicator can line up a job absolutely correctly, quicker than with a paper feeler; with the indicator there is the satisfaction of knowing at all times just how accurately the work is set.

Don't loosen bolts preparatory to raising or lowering the cross-rail before you have carefully wiped or scraped off all dirt on the face of the housings; the machine is often blamed for inaccuracies resulting from dirt behind the rail.

Don't forget that two straps and eight posts—two on each side—will allow you to take as big a cut on a heavy casting without its shifting as ten straps and no posts; the posts can also be set up quicker and their use gives more working surface on the top.

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MAKING THE DeVILBISS PLIERS—2

By ETHAN VIALL*

The Cam Operations

The process through which the cams of the DeVilbiss pliers go, from the cold rolled steel strips to the finished article, is comparatively simple, the steps being:

1. Blanking.
2. Flattening.
3. Trimming.
4. Drilling and reaming.
5. Burring on the disk wheel.
6. Tumbling.
7. Assembling.

The first four steps are illustrated at *A*, *B*, *C* and *D*, Fig. 24, while at *A*, Fig. 25 is shown the blanking die, and at *B* the blanking punch; *D* is the stock guide, and a simple pin acts as a spacing stop. *E* and *F* are the flattening punch and die and *G* and *H* the trimming punch and die. In using the trimming die, the punch is not, of course, set to enter the die on the stroke, but is set about the thickness of thin paper above it, so that one blank pushes the previous one through, and in this way the keen edge of the die is preserved much longer. The lever *I* on die *H*, is used to press the cam blank firmly against the stops; the pin on the lever really forming one side of a triangle of stops.

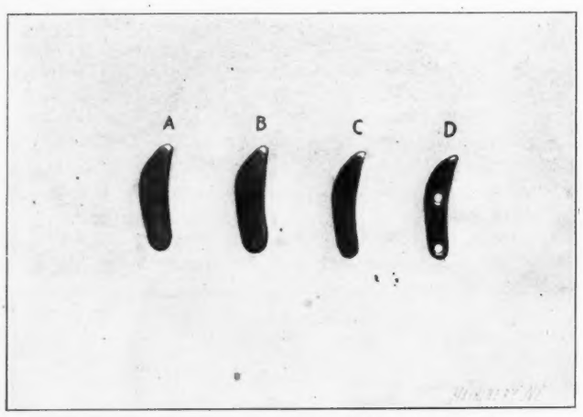

Fig. 24. The First Four Steps in the Making of a Plier Cam

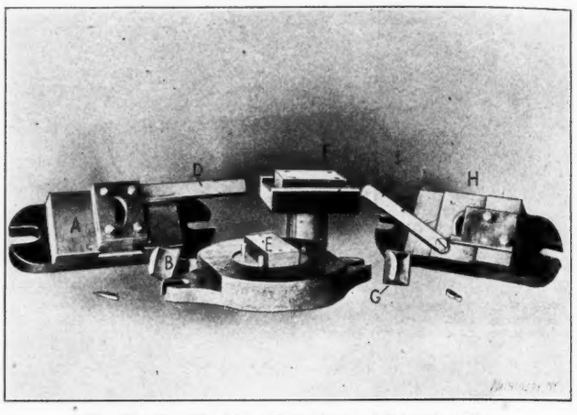

Fig. 25. The Blanking, Flattening and Trimming Dies

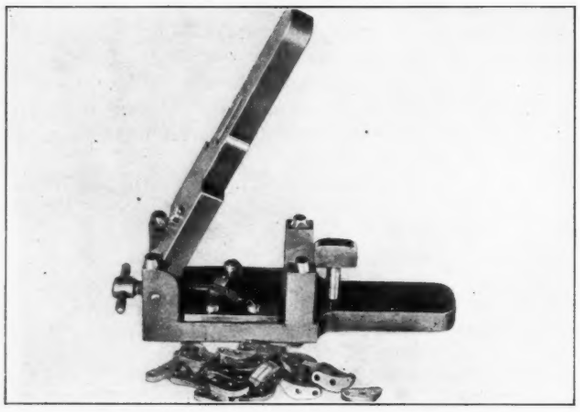

Fig. 26. Cam Drilling and Reaming Jig (Open)

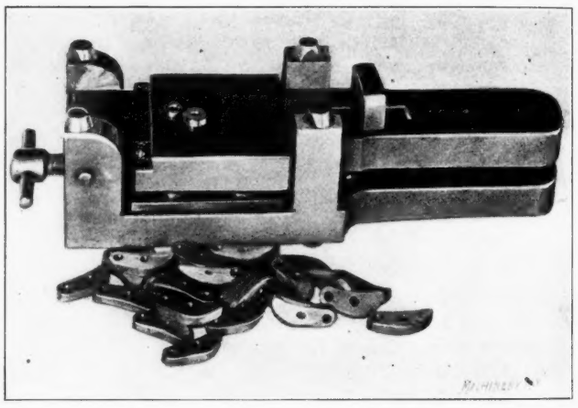

Fig. 27. Cam Jig Closed, Ready for Drilling

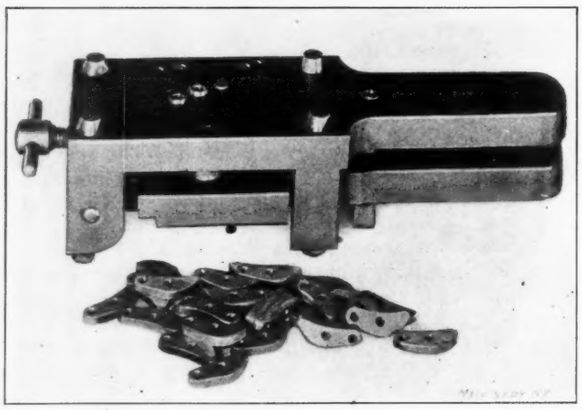

Fig. 28. Cam Jig Reversed, Ready for Reaming

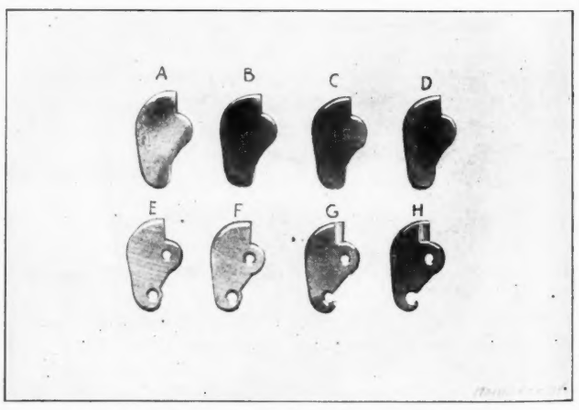

Fig. 29. Eight Steps in Making a Moving Cutter Blade

Combination Drilling and Reaming Jigs

The practice of drilling and reaming flat pieces in the same jig, is not uncommon, yet the methods differ considerably and as there is no simpler method than the one here shown, the jigs will be described in detail. Fig. 26 shows one of these combination jigs open with the drilled cam in position. It will be noted that the cam is located in the jig by stops in contact with the point and rolling side, and that the clamping-screw point comes in contact with the rounded end in such a way as to wedge the cam in firmly. The hinged cover also has a pin in it that presses the cam down firmly onto the lower plate as the locking thumb-screw is turned. The thumb-screw just mentioned has the head slightly beveled on the underside and this together with the threaded end that screws into the lower plate, takes care of any possible difference in the thickness of the cams and produces a firm contact. An objection might be raised here, that this would throw the drilling bushings out of line, but the cams are flattened to such uniform thickness that the error is too

* Associate Editor of MACHINERY.

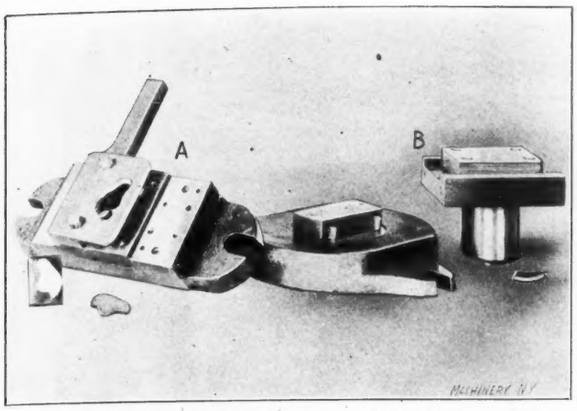

Fig. 30. Blanking and Flattening Dies for Moving Cutter Blades

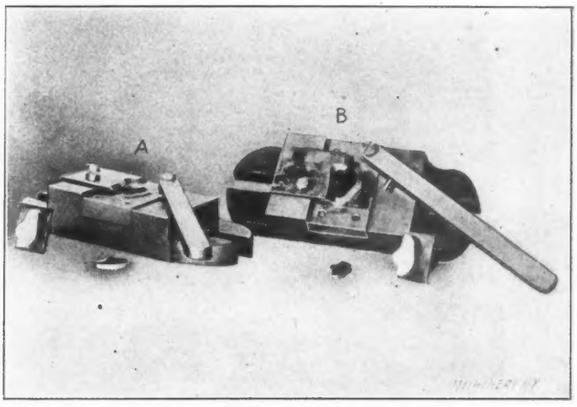

Fig. 31. Trimming and Shaving Dies for Moving Cutter Blades

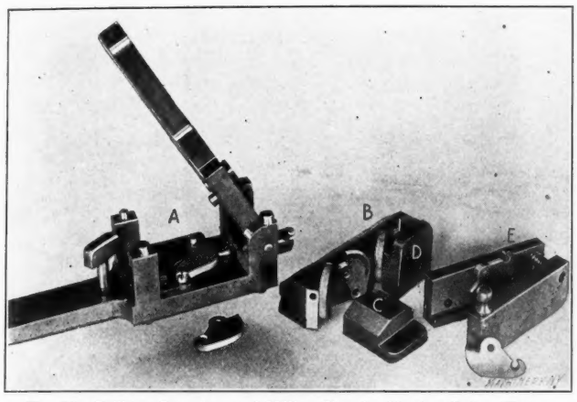

Fig. 32. Drilling, Reaming and Milling Jigs for Moving Cutter Blades

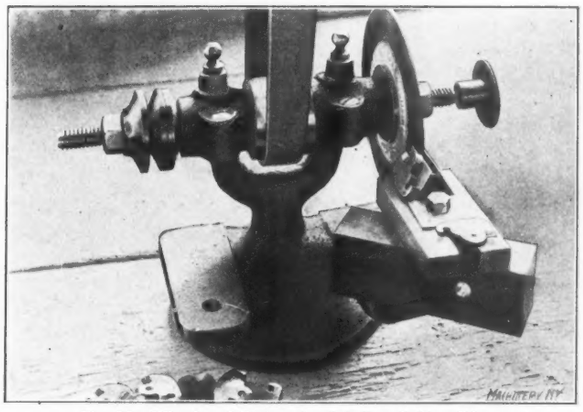

Fig. 33. Wheel and Fixture for Grinding Cutting Edges

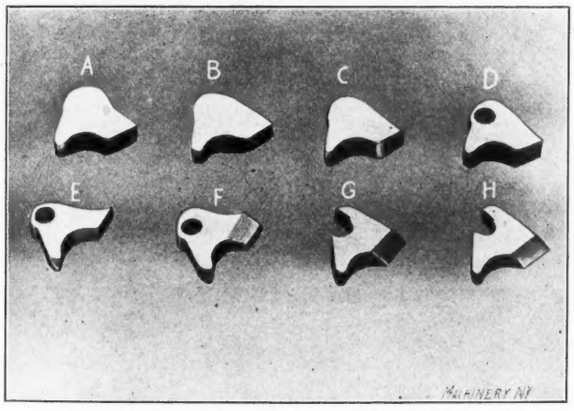

Fig. 34 Eight Steps in the Manufacture of the Fixed Blades

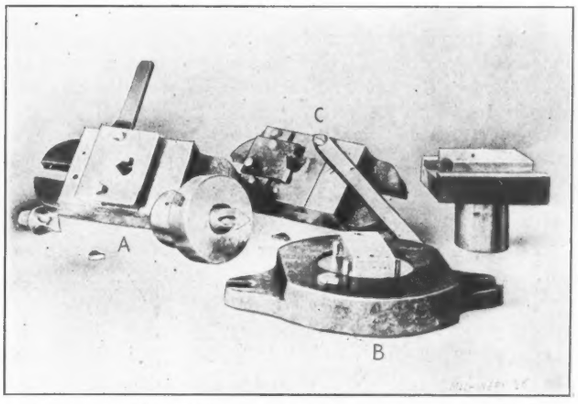

Fig. 35. Blanking, Flattening and Trimming Dies for Fixed Blades

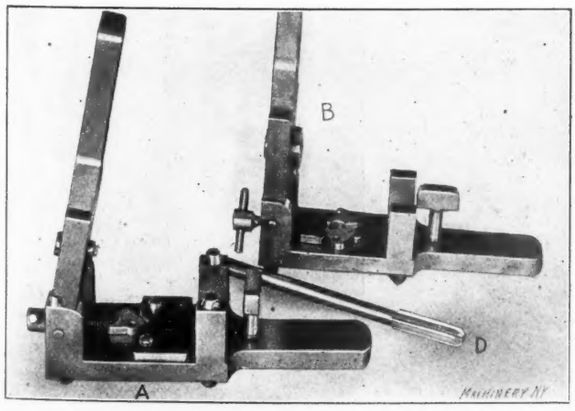

Fig. 36. Drilling and Reaming Jigs for the Fixed Blades

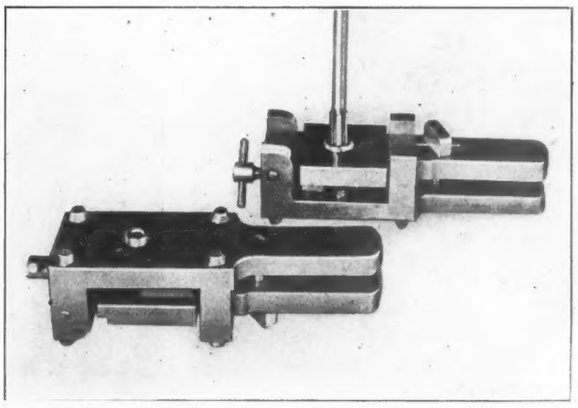

Fig. 37. The Jigs shown in Fig. 36 Closed and Ready for Use

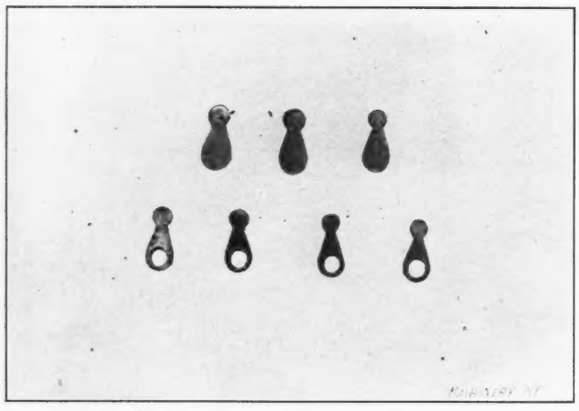

Fig. 38. Various Steps in the Manufacture of Plier Links

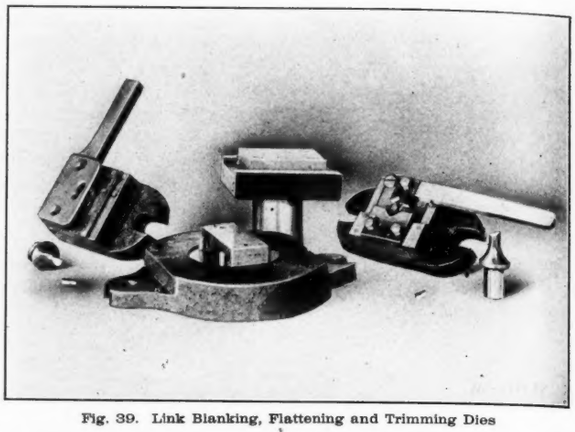

Fig. 39. Link Blanking, Flattening and Trimming Dies

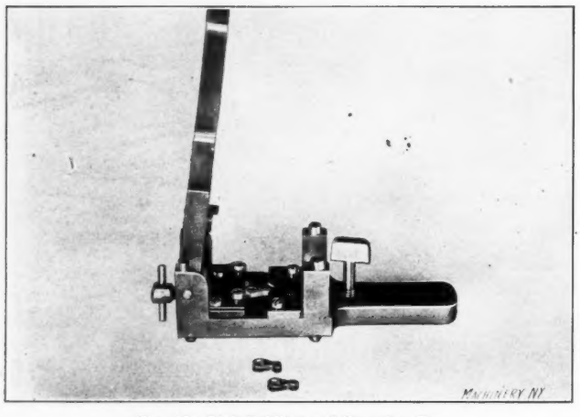

Fig. 40. Link Drilling and Reaming Jig

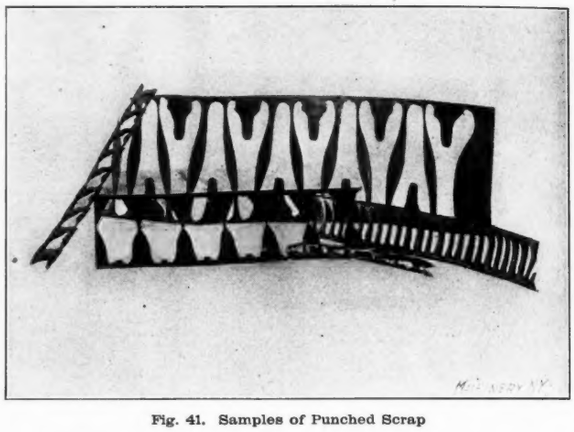

Fig. 41. Samples of Punched Scrap

slight to be reckoned with; indeed considerable variation can be allowed without causing any serious trouble. Fig. 27 shows the jig closed ready for drilling, and Fig. 28 shows it turned over ready for reaming. It will be seen that in the reaming operation, the jig rests solidly on its legs; there is no tendency for the bushings to be sprung out of line and the pin in the cover which holds the cam in place, allows enough space between the cam and the cover for end clearance as the reamers feed through.

After drilling and reaming, the cams have the burrs ground off by holding them on a disk grinder; they are then tumbled and sent to the assemblers.

Shop Operations on Moving Cutter Blades

The shop operations on moving cutter blades are as follows:

1. Blanking.
2. Flattening.
3. Trimming.
4. Shaving.
5. Drilling and reaming.
6. Burring on disk wheel.
7. Cutting edges milled.
8. Link hole slotted out.
9. Hardening in oil.
10. Tempering in oil.
11. Grinding cutting edges.
12. Grinding and polishing edges.
13. Polishing sides.
14. Assembling.

Fig. 29 represents these operations on each piece, as follows: *A*, blanked; *B*, flattened; *C*, trimmed; *D*, shaved; *E*, drilled and reamed; *F*, cutting edges milled; *G*, link hole slotted, and *H*, hardened and tempered.

Both the moving and fixed cutter blades are made of tool steel 15/64 inch thick, and after being blanked in the die *A*, Fig. 30, the moving jaws are flattened from 15/64 to 0.223 inch, which takes out the unevenness around the edges ready

Fig. 42. Polishing the Sides of the Cutter Blades

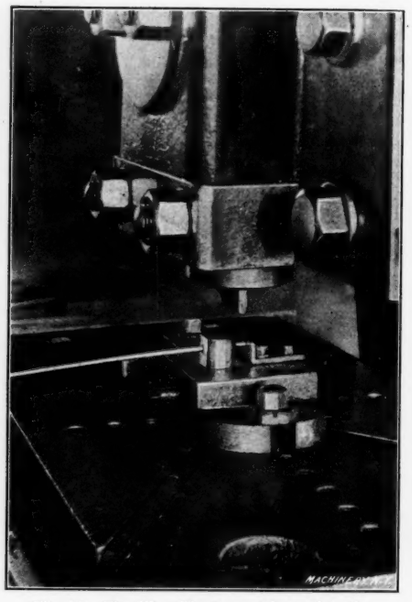

Fig. 43. The Way Rivets are sheared in the Punch-press

Fig. 44. Assembling the Cams and Jaws and Setting the Rivets

for trimming and obviates rough polishing, with a considerable saving. Next the flattened blanks are trimmed and then shaved to exact size in dies *A* and *B*, Fig. 31, respectively. As these dies are similar to those already shown, they will not be described. After the shaving operation, the blanks are drilled and reamed in the combination jig *A*, Fig. 32,

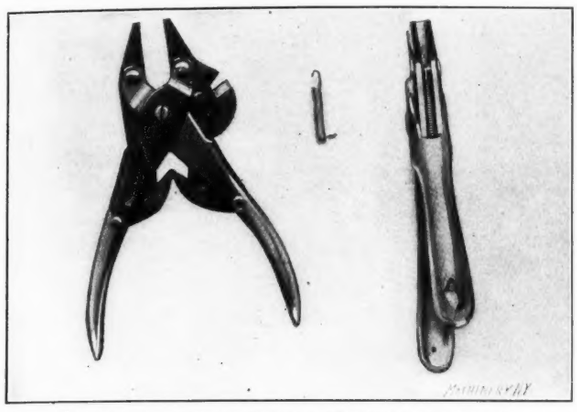

Fig. 45. View showing Position of Spring in a Spring Plier

which shows the retaining pin in the cover plainer than in the previously illustrated jigs for cams. Now the burrs are taken off on a disk wheel and then the blades are put in the milling machine vise jig *B*, and the cutting edges milled. In using this jig, four blanks are put in it, and with the clamping blocks *C* and *D* in place, it is put in the vise

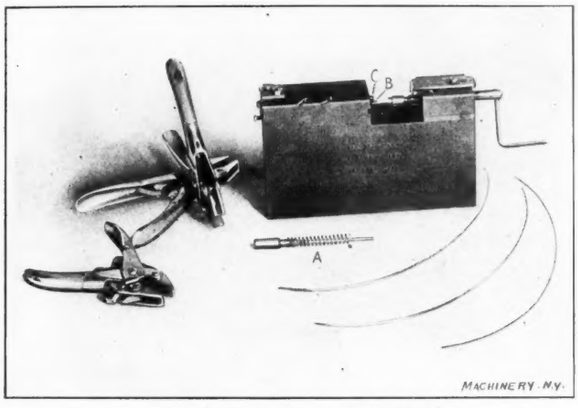

Fig. 46. Device for Winding Springs

and the vise tightened; then, using a small side cutting mill, one cut is taken which finishes the bevel for the cutting edge on one side of each blank, and then the blanks are switched in pairs and the final cut taken.

The link hole is slotted out, while the blank is held in the vise jig *E*, with an ordinary ½-inch milling cutter, the shape

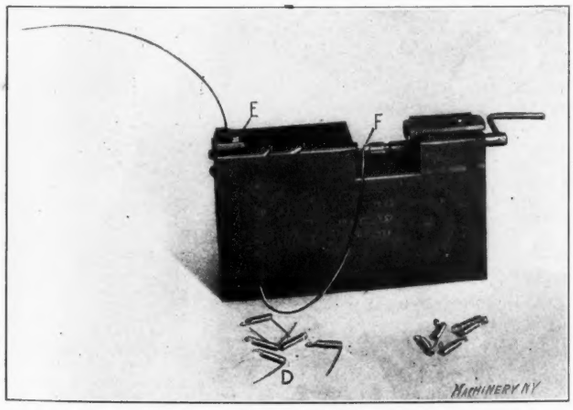

Fig. 47. Method of Starting a Spring

of the slot wanted and the position in which the blank is held making this possible. When the blades have been hardened and tempered, the cutting edges are ground by hand on a thin emery wheel, using the little slotted V-fixture, Fig. 33, for a guide. The edges are next ground and polished and then the sides are polished as in Fig. 42, after which they are ready for assembling.

Cutter Blades (Fixed)

The fixed cutter blades differ not only in shape but also in many of the operations which are:

1. Blanking.
2. Flattening to size.
3. Trimming.
4. Drilling and reaming.
5. Reaming out circle for inset of moving jaw.
6. Burring on disk wheel.
7. Cutting edges milled.
8. Drilled hole slotted out.
9. Hardening.
10. Tempering.
11. Grinding and polishing.
12. Assembling.

A, Fig. 34, is the blank; *B*, the flattened blank; *C*, trimmed; *D*, drilled and reamed; *E*, inset reamed; *F*, cutting edge milled; *G*, slotted, and *H*, hardened and tempered. In Fig. 35 *A* is the blanking die, *B* the flattening die, and *C* the trimming die. It will be noted that this blade is only trimmed once and not shaved, which is all that is necessary,

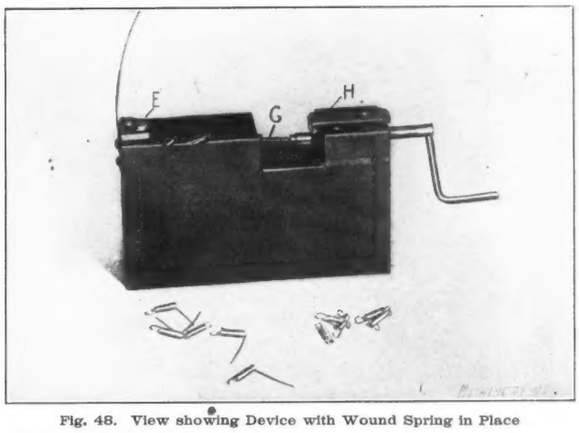

Fig. 48. View showing Device with Wound Spring in Place

as the parts that have any important bearing surface are reamed.

After drilling and reaming in the jig *A*, Fig. 36, the blades are put in the jig *B*, two at a time as shown, and the circle for the inset of the moving jaw is reamed out with the rose reamer *D*. The two jigs in this halftone are shown closed in Fig. 37.

The fixed blades are now burred on a disk wheel, the cut-

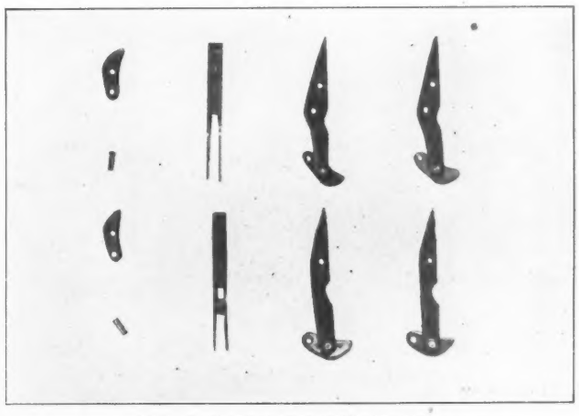

Fig. 49. Cams Assembled in the Jaws

ting edges milled as shown for the moving blades, and the drilled hole slotted out as illustrated in the parts *G* and *H*, Fig. 34, by holding them in the vise and using a suitable mill. These blades are slotted out in this manner so that they can be removed from the pliers when dull or damaged, without removing the rivet or using a screw in place of the rivet, which would be unsatisfactory for a number of reasons. The blades are next hardened, tempered, ground, polished and assembled.

Links

The operations on the links in the order in which they follow are:

1. Blanking.
2. Flattening.
3. Trimming.
4. Drilling and reaming.
5. Carbonizing.
6. Burring.
7. Drawing to a blue color.
8. Assembling.

The seven shop steps are shown in Fig. 38 and the tools used are shown in Figs. 39 and 40. After carbonizing, the burring operation serves to rough polish the parts sufficiently to show the blue color in the drawing.

Fig. 41 shows some of the scrap from which the various blanks were punched, which will show the way the metal was economized. The harder metal requires more waste space between the blanks than the soft and in the case of the handles, the strip is run through one way and then reversed in order to save metal, without using a double punch and die.

Screws, Rivets and Springs

The screws used in the center of the pliers to hold the moving cutter blades, are not made in the shop but are purchased from a specialty firm, though the hardening is done

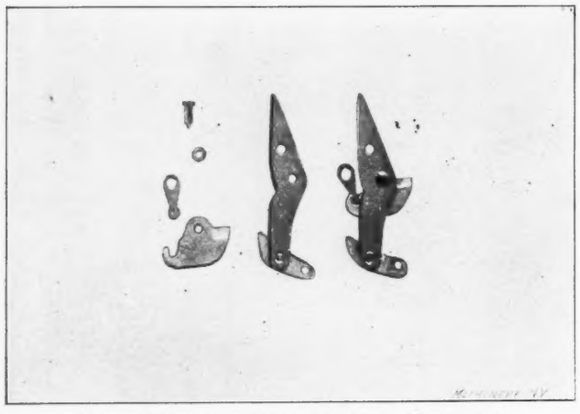

Fig. 50. Cutting Jaw with Cam, Blade and Link in Place

in the shop. The screws for the cutter blades are carbonized all through and then drawn just enough to prevent brittleness. An ordinary unhardened screw used in this place would be of no use whatever, as it would shear or wear out in no time.

The regular rivets used are cut from rods as shown in Fig. 43, though the rivets used in the spring pliers, have a groove

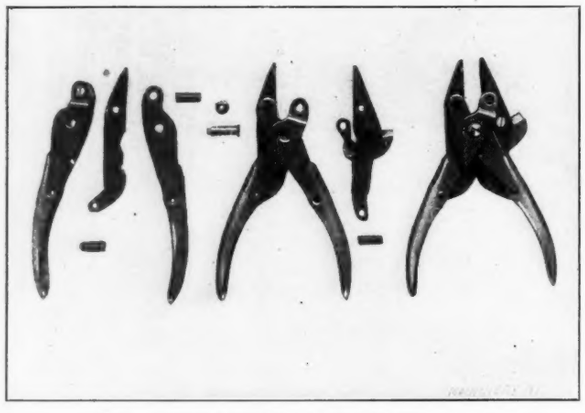

Fig. 51. Steps in the Assembling of Cutting Pliers

in the middle and so have to be cut off in a screw machine. The position of the rivet and spring is shown in Fig. 45.

Winding the Springs

A unique little spring winding device designed by Mr. DeVilbiss, by which a boy may easily wind accurate springs, is shown in Figs. 46, 47 and 48. Three different sizes of springs are wound with the device, a different sized winding mandrel being inserted for each size. One of the winding mandrels with its returning spring is shown at *A*, Fig. 46, and the projecting point of another, inserted and ready for use, is shown at *B*, while at *C* is a guide pin for the wire. A loop is first bent on the spring wire, like that shown on the springs in group *D*, Fig. 47, by bending in the little jig *E*. This loop is then inserted in the slotted end of the winding crank, as at *F*, which is pushed in far enough for the end of the winding mandrel to enter. The crank is now turned, winding the spring as shown at *G*, Fig. 48, the mandrel being drawn out by the tension of the spring coils as it is wound; but the instant the tension is released on the coils of the spring just wound, the mandrel flies back into its socket out of the way, allowing

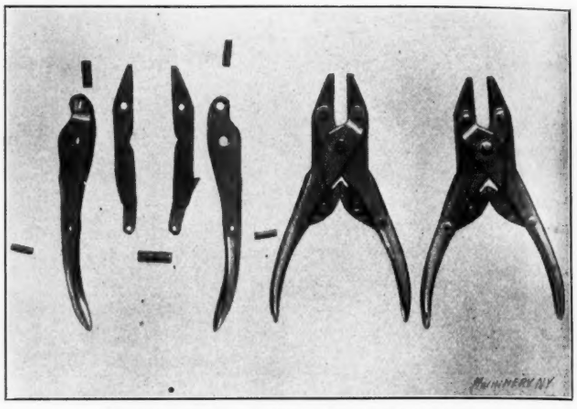

Fig. 52. Steps in the Assembling of Plain Pliers

the spring to drop down. The length to wind the various springs is gaged by the piece *H*, which points to a mark on the crank. The little loop on the opposite end of the spring is easily made by winding around a pin, when the small amount of superfluous wire is snipped off with a regular cutting plier the cutting blades of which have been left a little

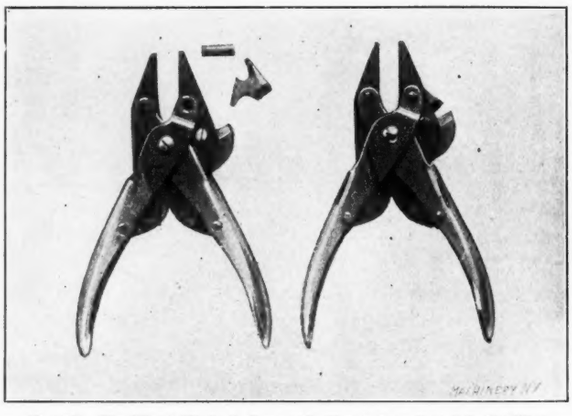

Fig. 53. The Fixed Blade before and after being placed in Position

harder than usual, which is necessary on account of the hardness of the wire used.

Assembling

The order in which the various parts of the pliers are assembled and made ready for shipping is as follows:

1. Putting cams in jaws.
2. Inserting moving cutter blade and putting in screw.
3. Putting in link.
4. Assembling complete, except fixed jaw and its rivet.
5. Fitting fixed jaw.
6. Spinning both ends of all rivets.
7. Inspecting, loosening, and testing cutters.
8. Burring center screw.
9. Polishing ends of jaws, screws and rivets.
10. Plating.
11. Buffing.
12. Washing.
13. Tumbling.
14. Inserting springs in the spring pliers.
15. Wrapping and packing.

Fig. 49 shows cams, jaws and rivets, separate and assembled, for both plain and cutting jaws, the parts being put together by a boy as in Fig. 44. The moving cutter blade and link are next put together as shown in Fig. 50, and then the cutting plier is assembled complete, as shown in Fig. 51, all except the fixed blade.

The plain plier having no cutter blades to fit, is assembled and the rivets spun down as illustrated in Fig. 52, but on the cutting pliers the fixed blade must be fitted as in Fig. 53, and the cutting edge brought perfectly in line with that of the moving jaw, which is done by inserting a pin in the hole in place of a rivet and then touching up the edge of the blade

on the little disk wheel, Fig. 54, which has one safe side. After the blades have been satisfactorily fitted and lined up, the rivets are spun down with a Grant rivet spinning machine Fig. 55, the plier as it looks before and after spinning being

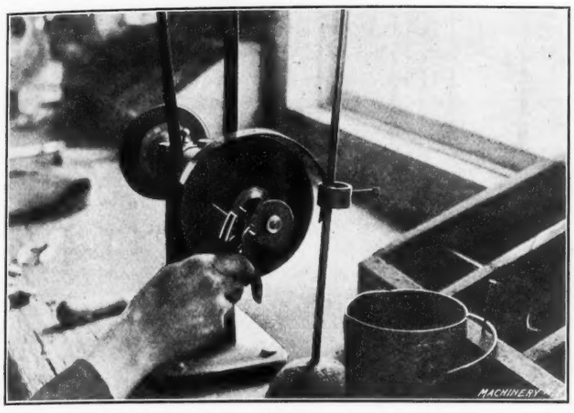

Fig. 54. Lining up and Sharpening the Cutting Edges

shown in Fig. 56. Fig. 57 shows a group of assemblers at work. The inspecting consists of seeing that the plier looks and works perfectly and cuts properly.

Burring or slightly riveting the center screw, is done to pre-

Fig 55. Spinning down the Rivets on a Grant Rivet Spinning Machine

vent the nut from working loose, and after the ends of the jaws, screws, and rivets are polished, the pliers are plated for one-half hour open and one-half hour closed, in the plating room, one corner of which is shown in Fig. 58. When the pliers have been buffed they are washed in a mixture of kero-

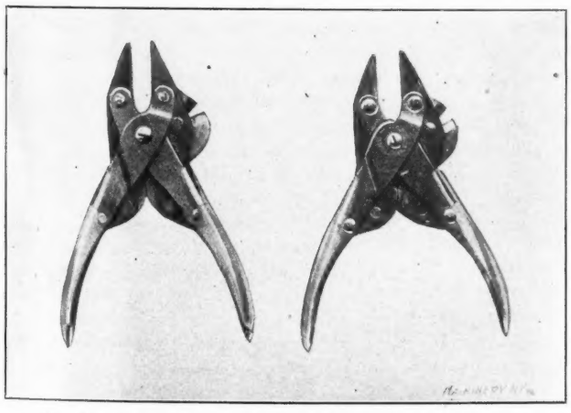

Fig. 56. Cutting Pliers with Rivets before and after being spun

sene and paraffine oil to cut and remove the polishing compound, and they are then tumbled in sawdust. In packing, the pliers are wrapped in a special rust-proof paper and placed six in a box ready for shipping.

In the general shop practice, high speed drills, reamers and tools of all kinds are used, and in the plier itself there are a few good points that it may be well to bring out, one of which is the making of the jaws of pressed steel instead of solid metal, which allows the cutters to be set in the middle where they belong, and it also allows the use of a high grade of tool steel for the cutters and a steel that can be carbonized, for the jaws, thus giving hard, but not brittle, serrations and edges.

* * *

THE CRACKING OF ALUMINUM CASTINGS

A few valuable hints regarding the prevention of the cracking of aluminum castings are given in *Castings*. To secure best results only new metal should be used. The aluminum should be melted rapidly, but the heat of the furnace should be kept low as compared with the heat of a brass-melting furnace. Just as soon as the metal is thoroughly melted, the crucible must be pulled, stirred, skimmed and the metal poured. If the metal is overheated or is allowed to soak in the furnace it will absorb gases which will fill the casting

Fig. 57. Group of Assemblers at Work

with pin holes. New graphite crucibles ought to be used, or such as have been used only for aluminum. When the crucible is pulled from the furnace, a small lump of sal-ammoniac or of chloride of zinc should be thrown on the surface of the metal before stirring and skimming. The pouring, at as low a heat as possible, should be rapid and through large gates, be-

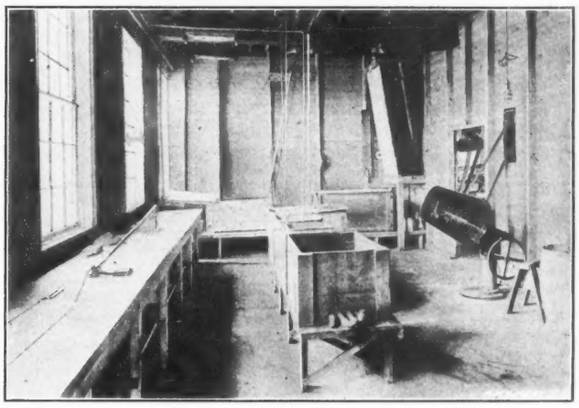

Fig. 58. View of Plier-plating Room

cause aluminum chills with exceeding rapidity. The cores for aluminum castings should be either of green sand or, if made up with a binder they should be thoroughly baked and as soft as possible. Aluminum shrinks a great deal when cooling, and if it cannot compress the cores internal cracks are likely to result.

* * *

The Verein Deutscher Eisenbahnverwaltungen (Association of German Railway Administration) has offered a total of 30,000 marks ($7,500) in prizes for inventions and improvements of special importance in railway traffic as well as for writings of exceptional merit relating to railway matters. The inventions and improvements must have been carried out practically and the written works to be considered must have been published between July, 1905, and July, 1911. The amounts of the individual prizes vary from $400 to nearly $2,000.

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MACHINERY

DESIGN—CONSTRUCTION—OPERATION

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We solicit exclusive contributions from practical men on subjects pertaining to machine shop practice and machine design. All accepted matter is paid for at our regular space rates unless other terms are agreed on.

JUNE, 1910

PAID CIRCULATION FOR MAY, 1910, 26,349 COPIES

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 300 pages a year of additional matter, and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

THE PISTON RING PROBLEM

Notwithstanding our conceded ability to solve problems in the manufacture of machinery, there seems to be no generally-known, first-class method of cheaply making piston rings for gas engines. By that we mean a method that can be depended on to turn out truly circular, well-finished, even tension rings at low cost.

The commercial methods in vogue are inaccurate, costly and unsatisfactory in result. The makers are not able to control all the factors entering the problem, and must follow more or less happy-go-lucky processes quite repugnant to the ideals of mechanics accustomed to precise methods of production. A practice that will turn out perfect rings, interchangeable and of uniform tension, is yet to be described.

* * *

FACE GRINDING

The grinding machine using a cup wheel is a machine tool of great present performance and of even greater possibilities. Already it has shown such marked superiority on certain classes of machine work that the milling machine is being discarded in its favor. It has some of the advantages over the axial grinding wheel that the face milling cutter has over the axial milling cutter. The power consumption is less and plane surfaces are produced with fewer passes of the wheel. There is also the advantage that the mean radius of the face grinding wheel remains unchanged until worn out. The economy of wheel material is high, inasmuch as a comparatively small part is wasted when the wheel is worn out, and moreover the cup wheel can be reinforced so that it is practically proof against bursting. For such work as machining the ends of machine legs, columns, joining the boxes of grinder frames and similar parts, the face grinder having a horizontal spindle with power-actuated table is unexcelled. The work is done quickly and with almost any required accuracy. If it should be of a comparatively rough nature, the grinder can be forced and the number of passes cut down to suit the most economical-minded manager. On the other hand, the finest class of work is performed with precision obtained only at much greater expense on the milling machine.

MAKING MACHINE PARTS WITHOUT WASTE

Mechanical progress is generally in the direction of saving labor, time and material, and improving the quality of finish and the durability of the product. Sometimes practice apparently moves backward as regards one factor, in order to gain greater advantage in another; and it is often hard to determine whether or not a new process has advantages in general. This is not the case with the process for making machine screws without waste, briefly described in the April number. The speed of production is unparalleled, the physical characteristics of the product are improved, practically no oil is used, there are no cutting tools to grind and set, except a cutting-off shear, and there is absolutely no waste of material. There is, however, a lack of desirable finish, which defect doubtless will be corrected when commercial machines are perfected. While now limited to small machine screws, the process will soon be applied to the manufacture of all ordinary commercial sizes of machine screws and wood screws. The possible saving of material and oil on all the machine and wood screws manufactured would amount to millions annually. It apparently means a revolution in the methods of manufacture of parts in which much capital is invested.

In the November number of MACHINERY, engineering edition, we referred editorially to the making of steel machinery chain without waste. The conclusions there drawn apply even more forcibly to the present development than to the manufacture of chain, and the saving of material and labor in the machine screw industry should add materially to our national wealth. The possibilities of cold forming machine screws, studs and similar products from wire and rod seem to be limited only by the ability of engineers to design and build machinery that will stand the stresses.

* * *

CLOSER RELATIONS BETWEEN DEPARTMENTS

As a manufacturing business grows, greater and greater difficulty is almost invariably experienced in keeping the various departments in harmony with the general spirit of the business and fully informed of one another's needs and activities. Unless an excellent system exists, deplorable differences in policy will develop, making it exceedingly difficult in some cases for other concerns to transact business satisfactorily with the purchasing department.

Take the case of an automobile manufacturing concern for an illustration: Certain parts are made by outside concerns to specifications furnished by its engineering department. These specifications state the character of materials, and are accompanied by blueprints giving dimensions, shapes, etc., some of which must be exactly as specified; but it is immaterial whether certain others be exactly reproduced or not. In making up their estimates, the engineers of the bidding concerns usually take into consideration the parts that must be made carefully and those on which less work is required, and figure the cost accordingly. If the work is to be strictly interchangeable throughout, using elaborate jigs and fixtures for all parts, immaterial dimensions would be faithfully reproduced; but in the class of work which is done in lots of a few hundred it is generally out of the question for the jobbing shops to build complete sets of jigs and fixtures. Everyone is familiar with the result of this system of manufacture—the essentials are right while the non-essentials are not wrong, although their dimensions may vary a sixteenth or an eighth inch one way or another; but when a shipment of parts made in this manner is received by an "unintelligent purchasing department" whose inspectors are held to a strictly literal interpretation of the specifications, trouble develops quickly. Cases are not unknown where goods have been rejected without consulting the engineering department, causing heavy losses to both the makers of the parts and the buying manufacturer. If a practical mechanic in authority had been shown the work it would have been accepted unhesitatingly, and every essential requirement would have been satisfied. The moral is that closer relations should exist between the purchasing and engineering departments, or that wide limits should be specified for immaterial dimensions so that work done in accordance with the spirit of the specifications will not be rejected by literal-minded inspectors.

THE HARDENING OF CARBON STEEL

The hardening of steel has always been considered an operation for which definite rules could not be laid down, but in which the experience and judgment of the hardener would almost exclusively have to be relied upon. Practically the only definite rules that have been laid down are that steel should be hardened at as low a heat as possible, and that there is a definite temperature for each kind of steel above which it must be heated to harden at all.

Apart from this meager information, a few generalities only have been furnished for the guidance of men doing this work, including directions for cooling, so as to minimize the risk of cracking; but definite information on the process of hardening is singularly lacking, and many have considered it impossible to shape rules for this operation, even as the result of careful experiments.

For this reason the experiments conducted by Mr. Shipley N. Brayshaw of Manchester, England, the results of which are recorded in detail in another part of this number, are all the more remarkable and of great interest to everyone engaged in mechanical work. These experiments appear to have been made with extraordinary care, and two of the points brought out in his investigations deserve to be particularly mentioned. One of them relates to the shortening or lengthening of steel in hardening. It has often been stated that steel is unreliable and not uniform in this respect, and that the same kind of steel has sometimes been known to shorten in hardening, and sometimes to lengthen. This phenomenon has been attributed to defects, or, at least, to special conditions in the steel, over which the hardener has no control. Mr. Brayshaw's experiments, however, show that the shortening and lengthening of steel in hardening follows a uniform law and that steel hardened below a given temperature, which he calls the "change-point," will shorten when quenched; whereas the same steel, if heated above this change-point before quenching, will lengthen. He also shows that by heating the steel in two furnaces, first bringing it up to a certain temperature in one, and then soaking it for a given time at a definite temperature in the other, it is possible to harden steel so that it will neither lengthen nor shorten when quenched. So far as we know, this is the first definite information that has been published on the change in the length of steel in hardening, the uncertainty of which has caused considerable difficulty in making accurate taps, dies, etc.

Another interesting point brought forth by Mr. Brayshaw's experiments relates to the proper hardening temperature. While it is possible to harden steel within a temperature range of about 200 degrees, and obtain what to the ordinary observer would seem to be good results, the *best* results are always obtained within a very narrow range of temperatures, approaching closely the decalescence point, or the temperature at which steel changes into a condition when it can be hardened by quenching. It is interesting to note that this result agrees with the old theory that steel should be hardened at as low a temperature as possible. In a number of cases certain tools are found to last exceptionally well, while other tools in the same lot show only ordinary durability, although no difference can be detected in the grain of the hardened steel. Such differences can now be accounted for by the slight variations in the temperature at which the various tools have been hardened.

These experiments open up an entirely new field for investigation and new possibilities in the hardening of tool steel. They indicate that in cases where it is important to prevent the cracking of tools in hardening and the deformation of tools due to internal stresses, they should be hardened at a temperature higher than that which gives the best results as regards hardness only. Thus we find that certain of the desirable qualities in a hardened tool are antagonistic; that is, we are unlikely to obtain a tool having extreme hardness and elastic limit and which at the same time is not likely to crack or lose its shape. Under these conditions one of the necessary qualities must be partly sacrificed to another, and a tool must be hardened so as to obtain good general results rather than the best specific one.

The influence of previous annealing on hardening is also of interest; and many of the points brought out in the abstract of the original paper are well worth considering. Those who are giving especial attention to the hardening of steel will find it worth while to obtain a copy of the original paper of 160 pages read by Mr. Brayshaw before the Institution of Mechanical Engineers of Creat Britain,* which records his experiments in minute detail.

* * *

THE MANUFACTURE OF FROGS AND SWITCHES

By J. B. HASKELL†

The description of frog and switch manufacture which follows is taken from the methods used by some of the best known firms in this country engaged in the manufacture of this line of work, and is especially based on the practice of the American Frog and Switch Co. of Hamilton, Ohio.

The rails as they come from the mills vary somewhat in length and size, and a great deal in quality, some of them

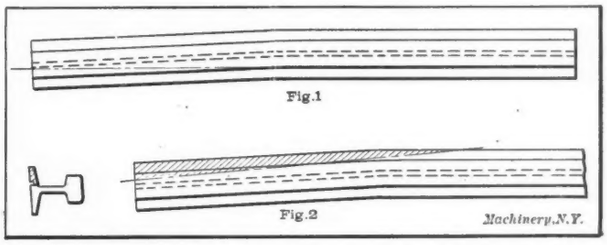

Fig. 1. Bent Rail for Switches. Fig. 2. Amount cut off Flange of Rail for Switches

being exceptionally hard; it often happens that a high-speed steel drill of good quality has to be reground for every two or three holes or even two or three times for one hole.

Switches

In the manufacture of switches, the rails are first cut to length by means of either an ordinary circular cold saw or a high-speed saw. When cut with a high-speed saw, the rail ends are made very hard by the action of the saw—often too hard for a tool to cut successfully if no means are employed to prevent the hardening. It is best prevented by running

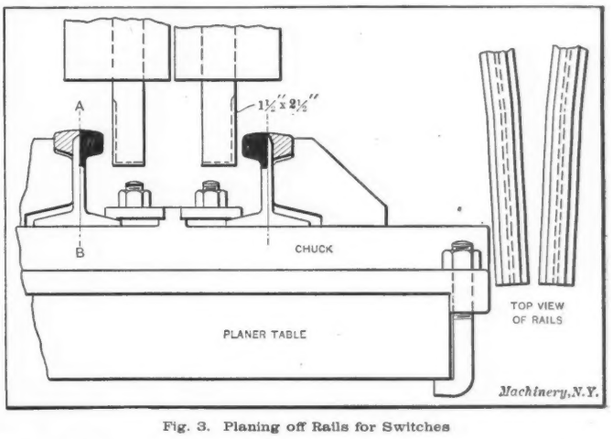

Fig. 3. Planing off Rails for Switches

the saw in water, the under side of the saw being covered to a depth of from two to six inches. Next the rails are drilled for the switch lug bolts and for the reinforcing bar rivets or bolts, if any reinforcement is to be used. The drilling is done in jigs or by means of templets. If the switch is to be reinforced the reinforcing bars are next riveted on.

In the next operation the rails are bent, as shown in Fig. 1, an amount sufficient to bring the side of the web at or near the gage line, the practice of different manufacturers varying somewhat; some place it at the gage line and others from ⅛ to ¼ inch from it. The bend is made of such a length that the point of bend occurs at the intersection of the line of the stock rail and the line of the back of the switch point railhead. This length is usually increased by an allowance of

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½ inch for each foot of bend length, which allowance has the effect of giving a slight clearance between the two rails at the bending point, thus allowing the end of the point to close tight before the point further toward the heel closes. Some makers then shear the part of the flange shown sectioned in Fig. 2, while others place it base up on a planer table, and after cutting a groove in it as shown, break off the flange.

The rails are then placed on a switch planer in special adjustable chucks, as shown in Fig. 3. The chucks are so made that their position may be adjusted both vertically and horizontally. The means for this adjustment are shown in Fig. 4, where the chuck is illustrated in detail. The rails are held quite rigidly, but owing to the spring of the rail and the shape of the tool there is some chatter. The portion of the rail-head shown in black, Fig. 3, is planed off by feeding each tool out separately by hand, two tools being used at once. The feed is by hand chiefly because the widths of the cuts vary so much on the same switch.

The line *AB* of the planing is arbitrarily determined, some making it at the center line of the web and others even with the side. The widths of the cuts vary according to the depth of rail-head, but usually run from one inch to two inches, the total depth being taken in one cut, as the tools are fed in from the side. The average cut is from 1½ inch wide by 3/32 inch feed to 2¼ inches wide by 1/16 to 3/32 inch feed. The speed of the planer which has been found to give the best results is 30 feet per minute, the return of course being considerably faster—usually from 40 to 50 feet per minute. The tools are of the shape and size shown in Fig. 3 and are of Novo steel. These tools when taking these cuts sometimes break off at the bottom of the holder.

The rails are now moved to such a position that the line of the unbent portion of the rail is in line with the planer. Both tools are then fed, thus planing off the portion shown in section lining in Fig. 3. The rail is planed on top in such a manner that the point will be from ¼ to ¾ inch below the top of the stock rail when it is in position on the friction plates, the amount varying according to the practice of the maker or the railroad. This planing is accomplished by setting the chuck vertical in such a way as to bring the required line horizontal. The tools are then fed down, for as the point is narrow, feeding sidewise would bend it. The gage line corner is rounded off to a radius corresponding to the radius of the corner of the rail-head. When this planing is finished, the rails are moved by a trolley and hoist to the next planer, which is equipped with chucks as shown in Fig. 5 for holding the rail in the position shown.

The tools on this planer are set at the proper angle to plane the flange so that it will agree with the angle of slope of the stock-rail flange, this angle being 13 degrees for all A. S. C. E. section rails. The portion of the flange shown in section lining in Fig. 5 is then planed off. This amount varies with the thickness of the riser to be used and with the thickness of the flange of the stock rail. The in-and-out adjustment of the chucks allows for this difference in the planing. On this cut the width runs up to 3 inches; on the widest part of the cut the feed is 1/16 inch. A broken chip is produced, which drops off in pieces of the width and depth of the cut and from ¼ to ¾ inch long on Bessemer rail, but on open hearth rail it is a long spiral chip. This cut finishes the

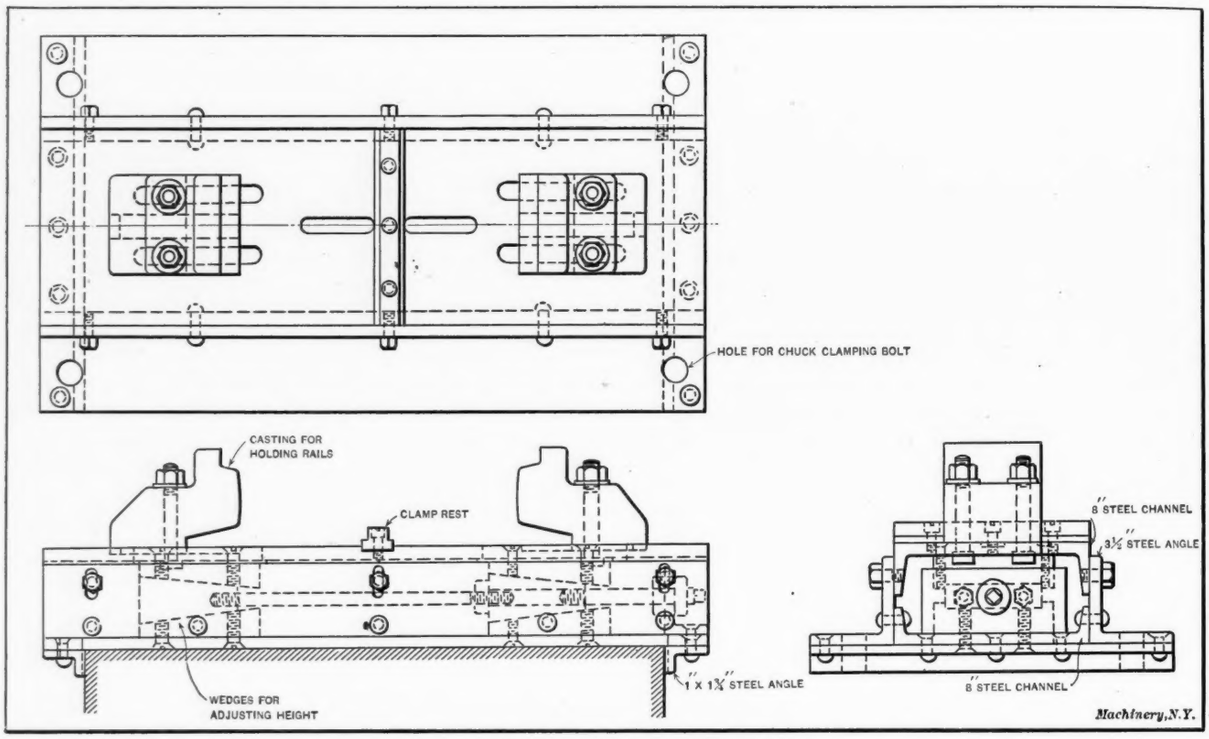


Fig. 4. Chuck for Holding Rails while Planing

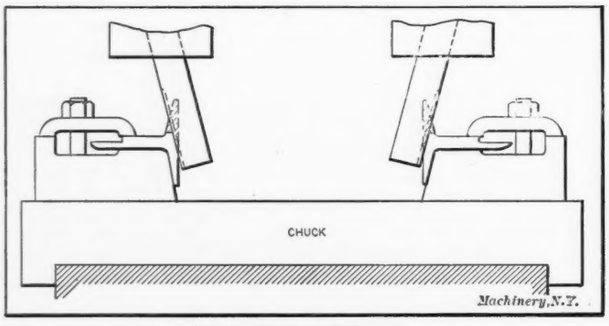


Fig. 5. Planing off Flanges

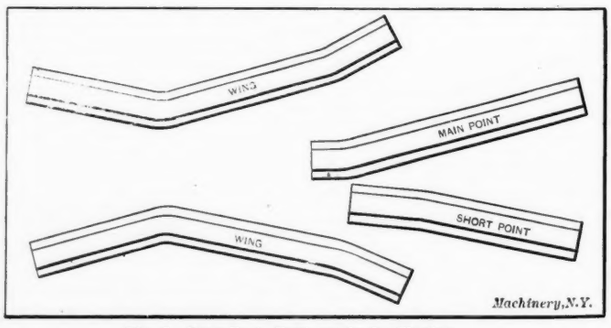


Fig. 6. Frog Parts Bent, ready for Planing

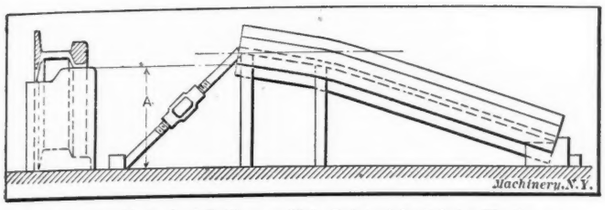


Fig. 7. Method of Setting up Main Point of Switch for Planing

switch except for grinding the top of the point end to a round corner.

Frogs

For the frogs as for the switches the rails are first cut to length. They are then heated and bent to the proper angle and shape. Each bend is made according to a templet, each

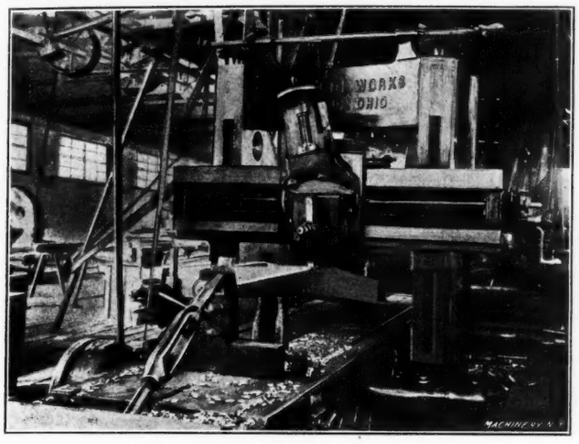


Fig. 8. "Balling out" Short Point of Frog

frog angle having its own set of templets. After the bending the rails appear as shown in Fig. 6. The wing flanges are then planed off the amount necessary to clear the flanges of the point rails. In doing this they are placed on the planer, base up, and two wings are planed at the same time. The short point is next planed out, the operation being called "balling out," to fit against the main point. The point is set up on the

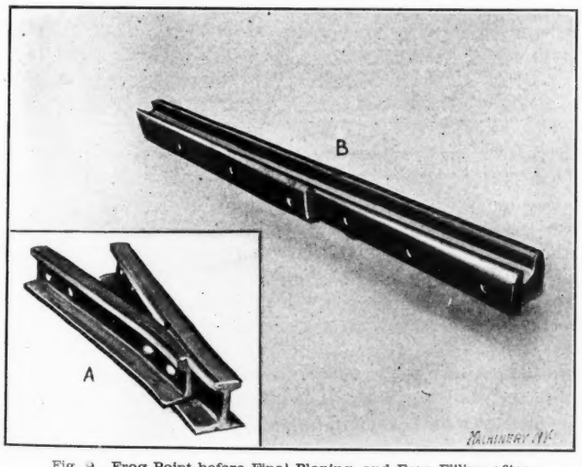


Fig. 9. Frog Point before Final Planing, and Frog Filling after Planing and Drilling

planer table as shown in Figs. 7 and 8, the distance *A* being governed of course by the frog angle. The planing line is marked on the end of the rail and it is then planed to this line. The cut in this case is not very heavy, it being 5/8-inch, with 1/32-inch feed. The two points after being drilled for two rivets and riveted together, as shown in Fig. 9 at *A*, are set on the planer and the bent part shown sectioned in Fig. 10 is cut off, thus forming the two intersecting gage lines.

Considerable planing is done on the filling, the approximate amount for an average standard frog being shown at *B* in Fig. 9, and in Fig. 11. As many pieces of a kind as there are, up to the capacity of the planer, are placed on it, set to the proper slope and are all planed at once as shown in Fig. 12. This work is done at a cutting speed of 25 feet per minute with a cut about 3/4 inch deep and a feed of 3/8 inch per stroke. The tool is 1½ inch by 2½ inches in size with a round nose. It is given a rake of from 5 to 8 degrees and a clearance of 2 degrees. Some makers instead of planing the filling do the work on milling machines.

The whole frog is next clamped up including filling, heel

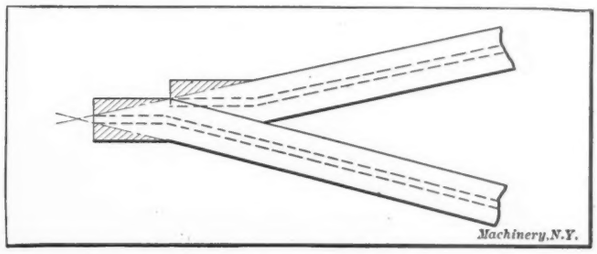


Fig. 10. Diagram showing Amount planed off Frog Point

risers and point fillers, if there are any, care being taken to secure proper alignment and length over all. It is then taken to a multiple spindle horizontal drill, whose spindles are set to the proper center distances for the frog being built, and the whole frog is drilled at once. This method avoids the reaming which is almost always necessary when the holes are drilled singly in the rails. Quite often when using an ordinary lubricant, the drills need considerable grinding when the rails are running hard. A mixture of camphor gum, turpentine and soft water may be used to avoid this trouble with

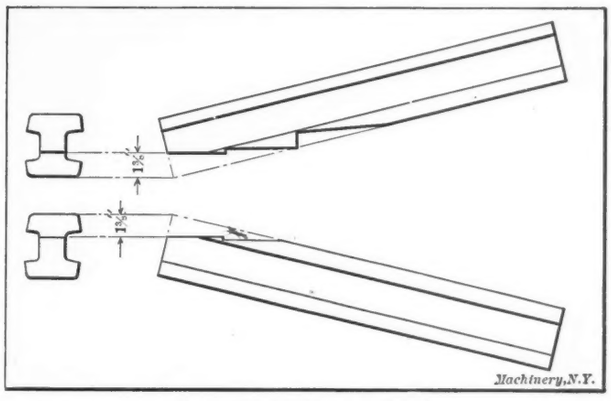


Fig. 11. Frog Filling when Planed

hard rails. After being drilled the frog is bolted up. In frogs having foot guards, etc., the extra holes are drilled at the same time as the frog bolt holes. The foot guards, plates, etc., are next bolted or fastened in place, completing the frog.

Crossings

The rails in crossings are first cut to lengths given on the drawings. They are then bent as required and the flange of the guard rail planed off if necessary. They are then assem-

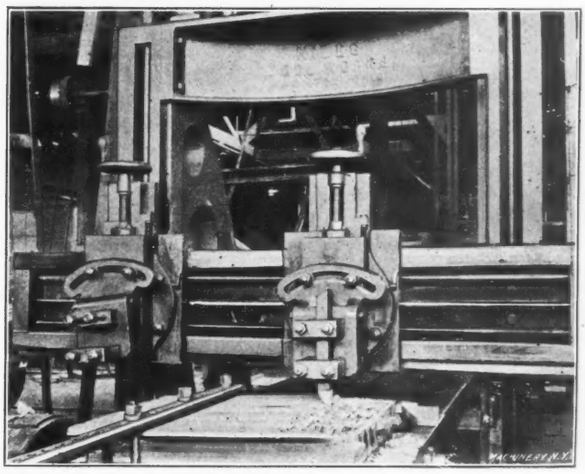


Fig. 12. Planing Frog Fillings

bled and clamped up in sections as shown in Figs. 13 and 14. Each section is drilled separately on a multiple spindle horizontal drill, all bolt and fishing holes being drilled at one setting.

The planing is next done, such as grooving out the flange-ways, shaping the ends of the abutting rails, notching the backs of the heads, etc. This work is usually done on a draw-cut shaper. The cuts are quite heavy, and even on the heaviest kind of shaper there is considerable spring in the table. The ordinary shaper has a brace supporting the outer side of the table, but it usually is so made that it has no holding-down power. When the heavy cut starts in on the rail it tends to raise the table. By altering this brace so that it also holds the table down, a big improvement is effected.

In setting rails to have the flange-way cut at an angle on the shaper, it is difficult to hold the rails properly, the cut

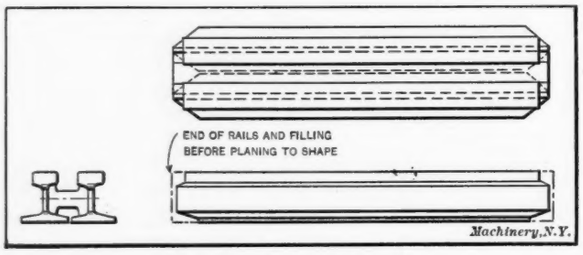


Fig. 13. Rail Section for Crossings

tending to turn the rail and holder and thus throw the angle out. The flange-ways are grooved out by means of a broad round-nosed tool. On curved crossings, where all the angles vary, each one is determined by calculation and the groove is then cut to the required angle. In shaping the ends of abutting rails, it is necessary to make two settings of the rail to properly plane both top and bottom. The cutting of the slope on the top of easer rails is performed on the planer by setting up the rail to the proper slope to give the needed rise.

The crossing is then assembled, the straps, after forging to the proper angle, are put in place, marked off and drilled, and the crossing bolted up. The plates, foot guards, etc., are fastened on and the crossing is complete. All dimensions

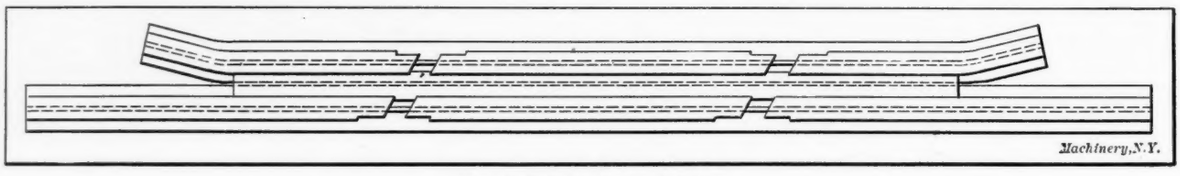


Fig. 14. Rail Section for Crossings

such as diagonals, etc., are carefully checked. Of course, in some details the practice of different makers varies considerably; the principal operations, however, are performed in much the same manner.

Use of Manganese Steel

Manganese frogs as now made consist of a manganese casting that forms the parts of the frog subject to the most severe wear. The wing and point rails are bolted to this casting. The bolt holes in the casting are cored ¼ inch larger than the bolts to be used. The rails are drilled by jig and are then bolted to the casting. The space around the bolts is then filled by spelter poured in through holes cored in the casting for the purpose. The entire top of the frog is then finished to a true surface by grinding. The manganese steel can be cut by a planer tool, but it is very slow work and the tools will not stand up well to it, making it cheaper and more satisfactory to do all fitting and finishing by grinding.

Rolled manganese steel is coming into some use in track work in the shape of full-length rails where the service is extremely severe. But for frogs, crossings and switch points the cast manganese steel is used altogether.

The regular types of cast crossings require no fitting at all, as the crossing is cast complete in two parts with fish bolt holes cored in the ends, which are made to correspond with the rail section.

THE MAINTENANCE, CARE AND UP-KEEP OF PNEUMATIC HAMMERS

By GEORGE H. HAYES*

Having been connected for a number of years with the manufacturing end of the largest pneumatic tool company in the world, I have been asked to write a few words concerning the maintenance of pneumatic hammers and the abuses which they receive at the hands of the men on the job.

The material used in the construction of pneumatic hammers is the very best that money can buy and is the result of long periods of experimenting at an outlay of a great deal of time and money to get material that is best able to withstand the vibrations, jar and wear which pneumatic tools are called upon to withstand. The treating of the material, fitting up, and testing, must be done by experienced and competent men. Pneumatic tools are made with the most extreme care, the moving parts are accurately and closely fitted, and when the proper lubrication is neglected, which is the most unpardonable offense to which a piece of fine machinery can be subjected, the moving parts of a pneumatic hammer will wear rapidly and in a very short time refuse to work.

Another source of trouble is sometimes located in the pipe line. Moisture carried in the air will rust the pipes and if a hammer is connected up without first blowing out the pipes a sediment is liable to be blown through into the tool, causing the valve or piston to stick. Rubber deteriorates very fast and particles of the hose may blow into the valve box and stop up some of the parts. Many times we have had hammers that would not operate, sent in to the factory, and on dismantling them found the port holes plugged up with pieces of rubber, or sediment from pipes, which when thoroughly washed out with gasoline, reassembled and properly oiled, would operate perfectly.

Another abuse is practiced in taking a hammer apart and putting it together again. Some repair men, instead of using a wrench or soft hammer in loosening or tightening the handle, use a hard steel hammer, battering the parts badly and in many instances breaking them. The finished parts should never be struck with anything but lead or copper hammers, and even when this is done, good judgment should be used as to the strain put on the threads of the handle and the cylinder.

There are many abuses practiced in connection with the operation of pneumatic hammers which are hard to locate, one of the most flagrant being the use of short pistons in riveting hammers. The manufacturers, after long and careful experimenting, have decided on a piston of proper length to perform satisfactorily the work for which the tool was designed, and all parts are made in proportion to withstand the strain. Workmen who are anxious to perform their day's task in the shortest possible time, or to increase their volume of work where they work on a per-piece basis, have little or no regard for these labor-saving devices. Having discovered that a piston a fraction of an inch short will do the work more rapidly, they resort to all manner of means to secure them, even having them made in outside machine shops. They carry them in their pockets and when they take a hammer from the tool room, they substitute the short piston for the one of proper length, again making the exchange before returning the hammer to the tool room. The result is, sets and handles are broken and cylinders frequently split. Where these breakages are occurring at short intervals, it would be well to detail someone to go through the shop and examine the pistons while the hammers are in use, otherwise the cause of the breakages will not be definitely located.

Some of the large plants using pneumatic tools, have adopted the practice of issuing a given tool to the same workman con-

*Works Manager of Chicago Pneumatic Tool Co., Detroit, Mich.

tinually, which has had a tendency to cause better care to be taken of the tools. If breakdowns occur frequently, it enables them to compare the amount of work being accomplished by different tools, and the more careless workmen are located and disciplined. Where this practice is followed, many times when the output of the shop is being forced to such an extent as to require all tools in service, and a workman is delayed in completing his work, while the men who are more careful of their tools finish in good time, it has a tendency to cause others to exercise greater care, which accrues to the benefit of all parties interested, even back to the manufacturer.

A great majority of men who operate pneumatic hammers in the shops, know very little, if anything, about the construction of the tools, and it pays any large institution using pneumatic tools to employ a competent man to look after them, see that they are properly lubricated and returned for cleaning when through with their work. I have been in foundries using large numbers of hammers in cleaning and chipping castings, where, at the sound of the whistle the hammers would be thrown down, generally in the sand, and enough sand or grit would get into the tool, so that when the air was again turned on the piston would stick fast after one or two blows. This necessitates a cleaning of the tool causing a loss of time in its use of from twenty to thirty minutes.

In starting to drive rivets in cold weather, especially on structural or out-of-door work, the hammer should be warmed up enough to take the frost out of the steel, as a hard piece of steel full of frost is liable to break at the first blow; after a few rivets have been driven, there will be enough heat from the rivets to keep the frost out. On the other hand, never allow the temper in the rivet set to be drawn too low, as a soft set will break very quickly. When driving rivets rapidly, have a pail of water handy and put the set and end of the hammer cylinder in the water occasionally to keep from drawing the temper, or change the set occasionally.

The wearing of parts in a hammer will always take place, but the life of the tool can be prolonged greatly by proper care and attention. Crystallization of the steel takes place owing to the rapid blows of the piston and the vibration. The life of the hammer depends mostly on the care which it receives and the character of the work being performed with it. A piece of fine machinery, such as a pneumatic hammer can be ruined in a few minutes by ill usage and neglect.

It has been proved conclusively during the past few years, that pneumatic tools are invaluable in shop practice wherein they are adaptable. Either a small or a large installation of pneumatic equipment is the most economical in maintenance cost. The small installation does not require a special attendant, but can be looked after by the regular mechanical force, reducing the labor charge to a minimum. With an equipment consisting of forty tools or more, it should be put in charge of a special machinist whose duty it is to follow the equipment closely and to keep it in good repair. It has been clearly proved that one man can care for one hundred tools where the proper attention is given by the men handling them. We have recently had our attention directed to tools in service which have been working regularly for a period of seven years. These tools, of course, have been well cared for, and the workmen using them appreciate their value in aiding them in their labors and handle them as they should be handled.

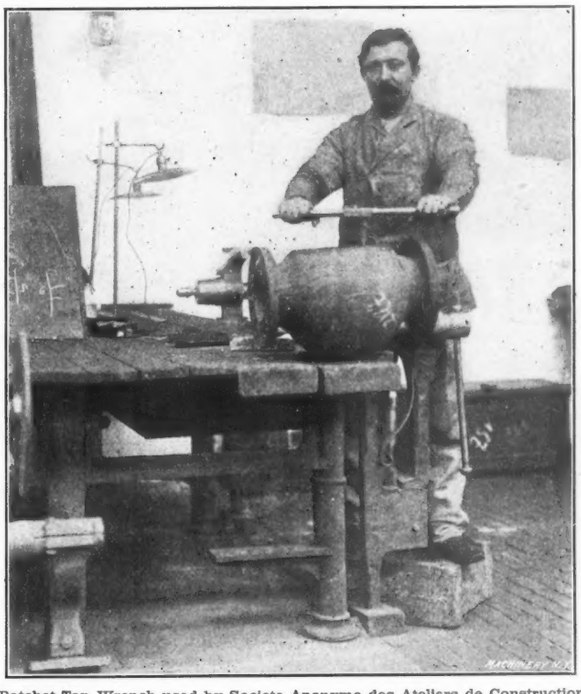
Pneumatic tools are outrageously abused in many cases without the knowledge of the management, and, at other times with their sanction, the latter being on account of these tools having such a large earning power that they are considered an economical investment even though their life be but three months. This latter remark may seem an exaggeration; however, it is borne out by actual knowledge. One of the largest steel concerns in the world is using chipping hammers where nine hammers in the hands of men skilled in their operation easily perform work which would require ninety unskilled men with mauls and cutters. The tools in this case are appreciated by both the management and the workmen and are well cared for. Even when the tools have a short life, a great many concerns having adopted them, state that the saving in wages and increased output make them an extremely economical investment.

Modern labor-saving machines are sometimes blamed for lowering the standard of skilled workmen by transferring him into a mere automaton—a droning machine tender. Undoubtedly in some crafts there is less call for men of manual dexterity than there was before the invention of labor-saving devices, leading to a decreased demand for all-around mechanics, and an increased demand for men of only sufficient intelligence to guide an almost sentient machine. On the other hand, many types of labor-saving devices have counteracted this tendency by offering mechanical means for doing the drudgery of a shop, making necessary a higher average of intelligence than before. Pneumatic hammers and drills, portable electric drills and hydraulic riveters are in this class, as skill and judgment rather than mere brute strength and endurance are called for in their operation.

* * *

RATCHET TAP WRENCH

In our shops those holes which we cannot tap by power on the Pearn drill press are tapped by the method shown in the accompanying photograph. The tool consists of a ratchet tap wrench so made that the workman cannot turn the tap backwards, or to the left. From this there results the advantage of a greater rapidity of work as well as the obviating



Ratchet Tap Wrench used by Societe Anonyme des Ateliers de Construction H. Bollinckx, Brussels, Belgium

of the back and forth movement of the tap, which deteriorates the cutting edges; the workman is inclined to habitually give this objectionable movement. The ratchet wrench is reversible so as to permit the tap to be withdrawn with facility.

SOCIETÉ ANONYME DES ATELIERS DE CONSTRUCTION H. BOLLINCKX

Brussels, Belgium.

* * *

Many problems in mechanism are best solved by avoiding them; that is, by resorting to other expedients that eliminate the troublesome feature. For many years various devices were tried in certain textile machinery to overcome the momentum of spools which caused them to over-run when winding was stopped. The consequent double reversal of motion when winding started again would often snap the thread before the inertia of the spool could be overcome. Thousands of dollars were spent on many devices designed to overcome the trouble, but with little success. At last the problem was solved by getting around it. In winding nowadays the spool does not turn. It is mounted with its axis parallel to the direction of the thread travel, and the thread unwinds from the end of the spool without rotating it. In this simple manner the effect of inertia is eliminated.

MAKING WALSCHAERTS VALVE GEAR PARTS

By RALPH E. FLANDERS*

Every mechanic really interested in mechanics, who chances to live near one of the great trunk line railroads, must have noticed a remarkable change in locomotive design which has taken place in the last three or four years. We refer to the increasing use of the Walschaerts valve gear. A locomotive equipped with this gear, as shown in Fig. 1, presents a distinctly different appearance from one furnished with the old-style Stephenson link motion, which is mounted out of sight between the frames of the engine. This difference in appearance is especially noticeable with the engine running at high speed when the lines of flashing light made by the flying steel work of the rods and links give a decidedly mazy and complicated appearance to the mechanism.

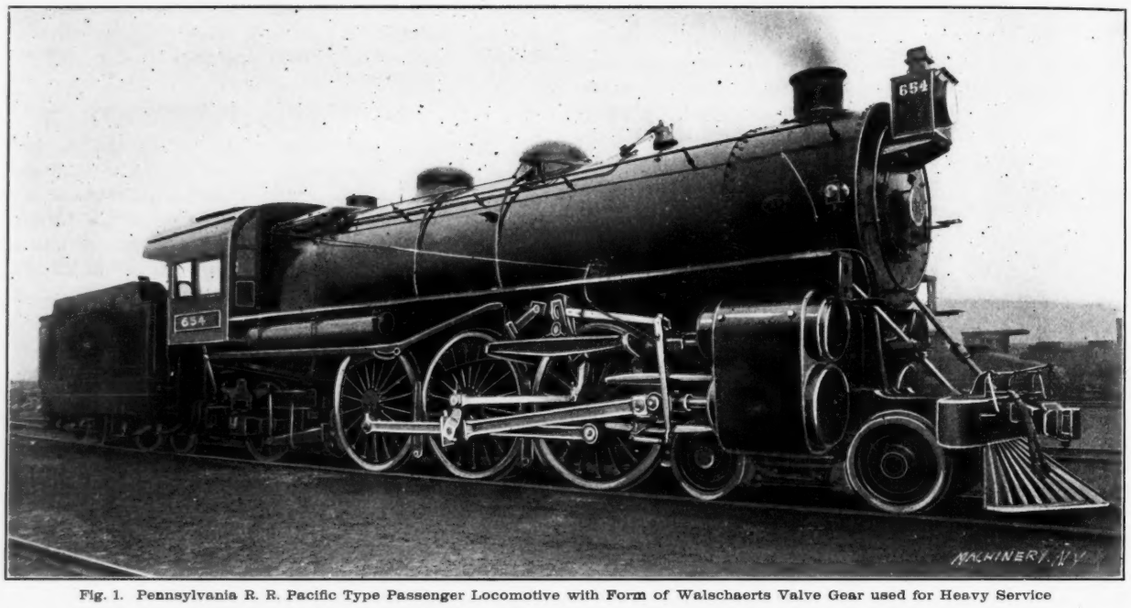


Fig. 1. Pennsylvania R. R. Pacific Type Passenger Locomotive with Form of Walschaerts Valve Gear used for Heavy Service

The Advantages of the Walschaerts Gear

In reality, however, the Walschaerts gear is not as complicated as the Stephenson type. The deciding factor in its adoption, as every railroad man knows, was not the matter of complication, but of dimensions. Of late years engines have grown so tremendously in size and power that it has become next to impossible to find room between the frames, for eccentrics and valve movements of sufficient size and wearing area to give strength and durability for the heavy service required of them. Besides this, the large diameter of the axles of heavy locomotives requires an eccentric of correspondingly large diameter; and with this, the surface speed of the bearing of the eccentric strap on the eccentric is so great as to practically nullify the effect of any increased area which could be given to it by careful designing. These considerations led to the adoption of a form of valve gear which was located entirely outside the wheels, where no serious dimensional limitations were placed on the parts.

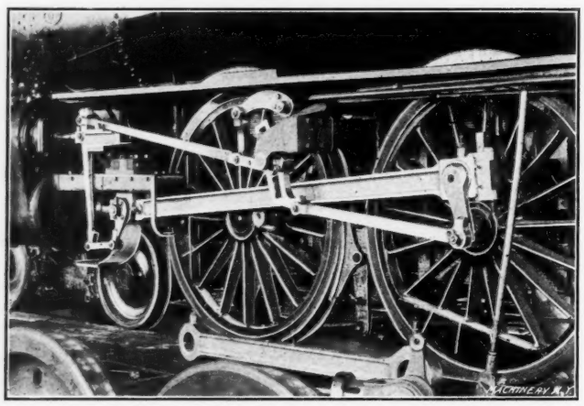


Fig. 2. Design of Walschaerts Valve Gear used on Atlantic Type Engines

Wnen it came to the actual application of the new motion to the locomotive, it was found to have further advantages. One of them lay in the fact that it is always exposed to the view, making it very easy to erect and maintain, leaving it open for the constant inspection of the engineer. Besides this, it may be easily so designed that all its movements are in straight lines, without canting or side strains, thus particularly adapting it to heavy service. In the matter of steam distribution and economy, there is little to choose between the two, though the old gear may have a slight advantage.

We have referred to the Walschaerts gear as a "new" form of gear. This is true, however, only for American service. It has been used to a limited extent in England, but on the Continent it has been employed almost to the exclusion of any other form of valve gear ever since its invention by the Belgian, Egide Walschaerts, about 1844. Although we were so long in applying it in this country, its good qualities were rapidly recognized when once the start was made, as is evidenced by the fact that of 2448 locomotives ordered in this country last year, 1638, or about 67 per cent were of the Walschaerts type; 30 per cent were of the Stephenson type; while the remaining 3 per cent of the total number were furnished with other designs of valve movements, some of which were of a more or less experimental nature.

Two Designs of the Walschaerts Gear

The first two illustrations show the mechanism as applied to the locomotive. Different designs are shown in the two cases, that in Fig. 1 being used for the heavy service, while that in Fig. 2 is adapted to lighter work, being applied in this case to the standard Atlantic type passenger locomotive of the Pennsylvania R. R. The main difference relates to the method of raising and lowering the radius rod in the link, the connection between the radius rod and the link block, and the support of the link.

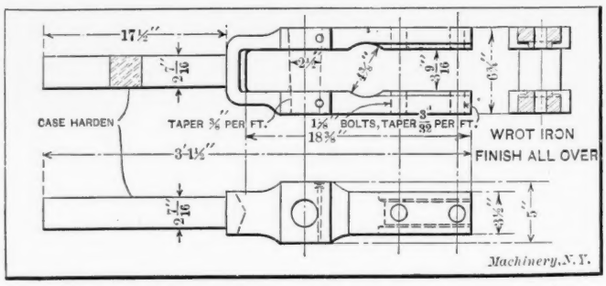


Fig. 3. Radius Rod Extension for Valve Gear shown in Fig. 1

* Associate Editor of MACHINERY.

In Fig. 1 the link is mounted on swinging yokes on each side, pivoted to bearings on a cast-steel frame. The radius rod is provided with an extension, which spans the link on each side inside of the yokes and is provided with a finished square shank projecting beyond the link, which bears in the

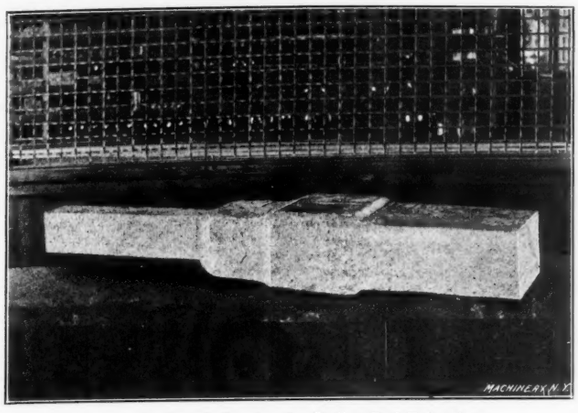


Fig. 4. Rough Forging for Radius Rod Extension

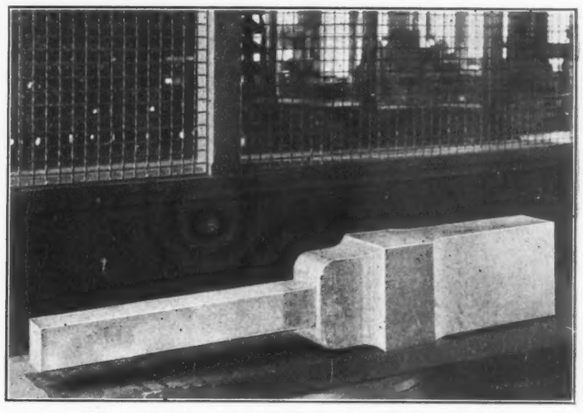


Fig. 5. Forging Roughed all over and Shank Finished

pivoted block on the end of the reversing arm, by which it is raised and lowered for forward and backward running. In Fig. 2 the link is supported in trunnions or saddles at the center, and the radius rod is hung from the reversing arm on a short link.

The operations on the rod work of the valve mechanism in the Juniata shops do not differ materially, except that the work is smaller, from the method of manufacture used in making the main and side rods, described in the February, 1910, number of MACHINERY, railway edition. In describing the shop operations on this valve gear, we will, therefore, confine the description to two particular parts of a special and peculiar design —namely, the links for both types of valve gear, and the radius rod extension for the heavier type of locomotive shown in Fig. 1.

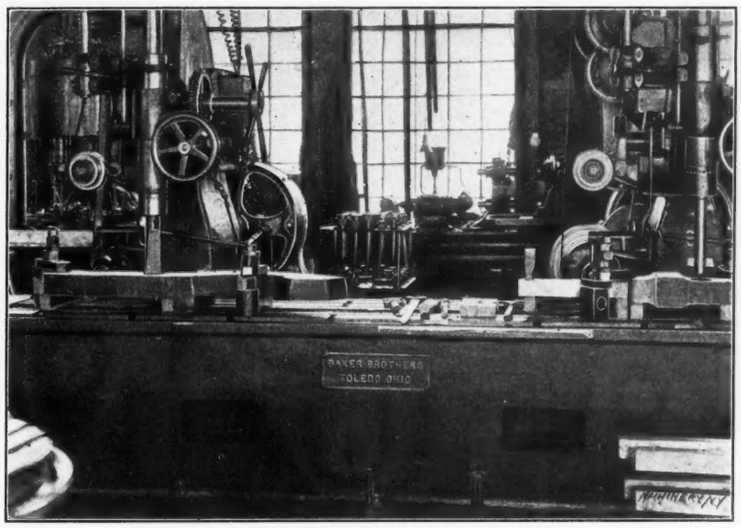


Fig. 6. Drilling Radius Rod Extension and Walschaerts Links

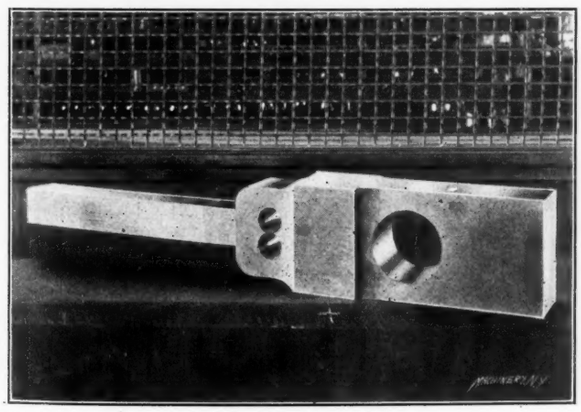


Fig. 7. Radius Rod Extension Drilled for Slotting

Roughing Out the Radius Rod Extension

A drawing of the radius rod extension is shown in Fig. 3. As may be seen, it is made from a wrought-iron forging, and is finished all over. The square projecting shank, which bears in the pivoted block of the reversing arm is casehardened to give a durable wearing surface. This casehardening, as will be explained, introduced some difficulties in the course of manufacture. The overcoming of these difficulties gives the part its particular interest from the machinist's standpoint.

The rough forging from which the piece is made is shown in Fig. 4. The illustration shows that the ends of this forging have been trimmed to size in the cold saw to practically the required length for the finished piece. Fig. 5 shows this forging roughed out all over. The various cuts shown have been taken in the slotting machine and the shaper. On the shank, which is to be casehardened, the finish marks show that the stock was necked out close to the connection with the body of the forging, the cuts being taken crosswise of the work on the four sides on the slotter. The forging was then taken to the shaper and the square was finished down to size. This, of course, is the obvious method of procedure.

The holes haxe next to be drilled for slotting out the interior of the blank to form the two arms which encircle the link. The machining of these holes is performed on a heavy drill press; or, as in the case shown at the left of Fig. 6, on a regular rod boring machine, using only one of the spindles, leaving the other free for other work. The larger hole is first drilled out, and then it is bored with a bar carrying a double-edged blade, as shown in the engraving. After these boring and drilling operations, the work has arrived at the stage shown in Fig. 7.

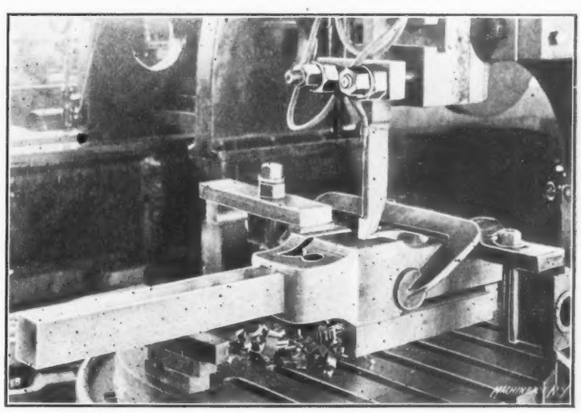


Fig. 8. Working out the Slot in the Slotting Machine

The forging is now taken to the slotting machine, where (see Fig. 8) it is mounted on parallels, so as to hold it firmly and accurately to the table of the machine. A square-nosed tool is used for cutting out the block of stock between the

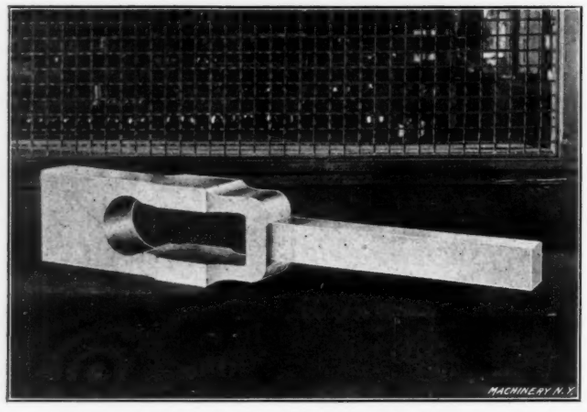


Fig. 9. Work with Center Slotted out ready for Casehardening

holes. The C-clamp, which is shown tightened in place on the forging, prevents the two sides of the newly formed opening from separating under the pressure of the cut. The state of the work at the end of this operation is shown in Fig. 9.

Casehardening the Shanks of the Radius Rod Extension

It has been found advisable to caseharden the shank at this point in the procedure. The advantage of doing it at this time lies in the fact that the remainder of the work is not yet finished to its critical dimensions, and the two sides are still tied together by the mass of material left between them at the outer end. Thus the distortion which is sure to take place in work of this kind in hardening, takes place at a time when it does no harm, as the finishing cuts will be taken with reference to the finished and casehardened surfaces of the shank, with which they will, therefore, be true and accurate. If the opening between the two sides was completely cut out, as shown in Fig. 3, before this hardening operation, they would almost certainly be sprung out of parallel with each other, or out of line with the casehardened portion.

Fig. 10 shows the casehardening furnace and two pieces of work ready for heating. The furnace is fired with oil, and supplied by a blast from the regular blower service of the forge shop. Provision is made, however, for an independent blast for keeping the fire up during the night or at times when the regular forge service is not in operation. This independent service is furnished by a small blower fan, which is itself operated by impingement on its blades of a jet of air from the high-pressure shop service line, used for the pneumatic hammers, riveters, etc. This latter is kept at pressure continually, day and night, so it is available any hour of the twenty-four, making it possible to use the furnace at any time or for any length of time.

As may be seen in Fig. 10, only that portion of the work which is to be hardened is packed. This is inserted in a section of wrought iron pipe, filled with the casehardening material, composed of 11 pounds of prussiate of potash, 30 pounds of sal-soda, 20 pounds of coarse salt and 6 bushels of powdered charcoal (hickory-wood charcoal preferred), thoroughly mixed with 30 quarts of water. The pipe is luted with fire-clay at each end to retain the carbonizing material and exclude the air. The work is placed in the furnace as shown in Figs. 11 and 12. The part that is not to be made hard is left projecting outside the furnace door. A wall of fire-brick and clay is built up to close the space between the lower edge of the door and the bottom of the furnace opening. After soaking for, say, fourteen hours more or less, the work is removed from the furnace and from its packing, and plunged into a tank of water as shown in Fig. 13, being suspended there until cool.

Test Pieces for Casehardening

Fig. 13 also shows a square block of hammered iron marked "Test piece." The use of this test piece gives an idea of the precautions which the Pennsylvania officials have found it wise to adopt, to make sure that all the material and treatment given to the vital parts of their locomotives, are up to the standard required of them. This test piece is forged at the same time and from the same material as the radius rod extensions. It is machined to the same dimensions as the square shank of

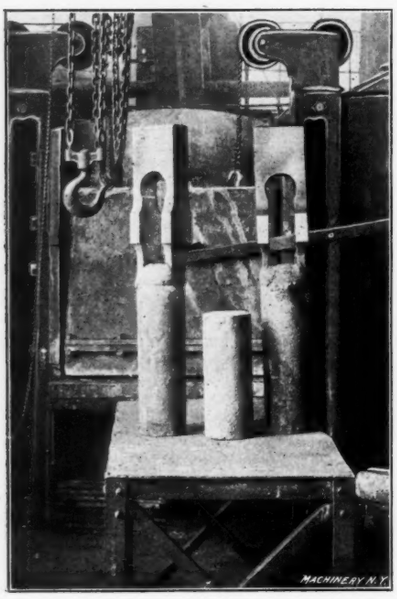


Fig. 10. Work and Test Piece Packed for Hardening

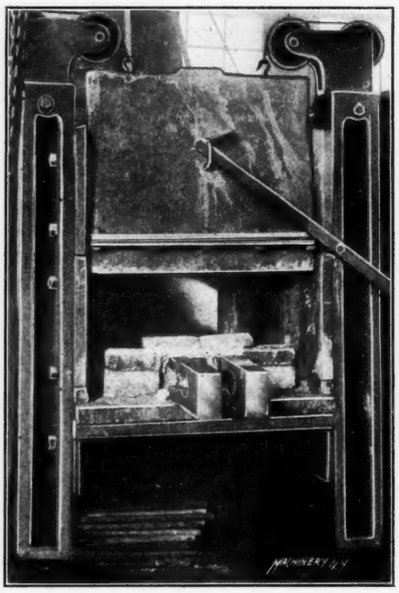


Fig. 11. Work placed in Furnace ready for Casehardening

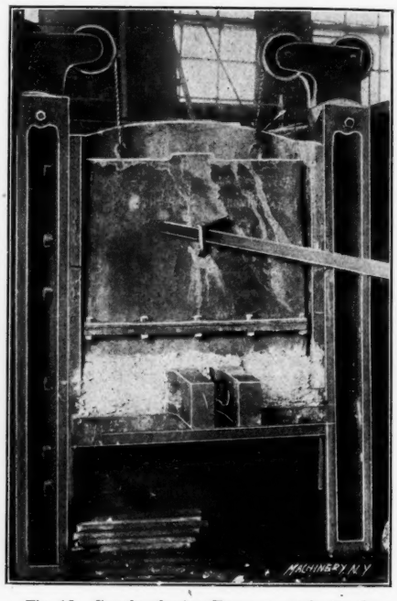


Fig. 12. Casehardening Furnace ready for the Heating

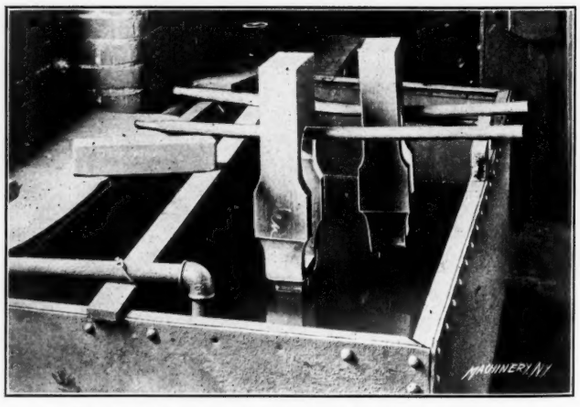


Fig. 13. Cooling the Casehardened Shank of the Work

the extension which is to be casehardened. It is packed in a similar wrought iron casing, as shown between the two pieces of work in Fig. 10, and is placed in the casehardening furnace next to the work itself, remaining there for the same time and subjected to the same degree of heat. It is then cooled and hardened in the same manner. It is evident, then, that the condition of the test piece should give an accurate index of the condition of the work itself, so far as the hardening operation is concerned.

The test piece, thus prepared, is now taken to a press and broken, in order that the condition of the interior may be noted. Figs. 14 and 15 show various examples of these broken test pieces. The examination shows the condition of the metal, the texture of the fiber, and the depth of the casehardening. One-half of each test piece is thrown away. The other half is retained, marked with the date of hardening and the class and construction number of the engine on which the casehardened parts are to be used. These are kept two years to prove that the work is giving good results in service, and to make sure that no trouble is to be expected from it. It is held by the shop as a sort of guarantee of the good work done in the heat treatment.

Fig. 14. Broken Test Pieces for Showing Condition of the Work

Such precautions would be necessary or advisable in hardly any other kind of work, but there are many cases in locomotive practice where the extra expense and trouble is worth while. A defect in a locomotive is a serious matter. It may mean nothing worse than the delay of thousands of tons of valuable freight, or it may mean the loss of human life and serious damage to the prestige of a great railway system. Good steel properly treated is absolutely essential for the vital parts of a locomotive, and every precaution is taken to insure reliability.

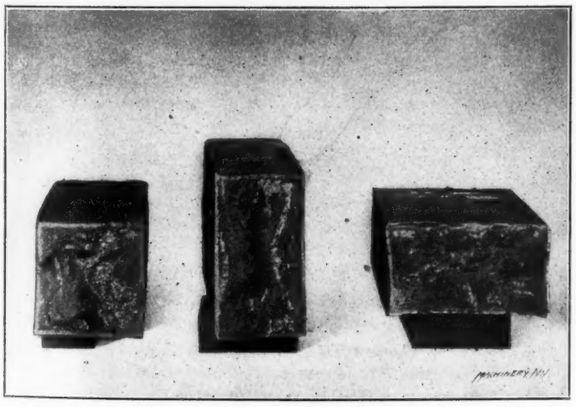


Fig. 15. End View of Test Pieces showing Depth of Hardness and Character of Fracture

It was mentioned that ground coke is one of the ingredients used in casehardening. Fig. 16 shows the mill used here for grinding the coke. The coke had formerly been broken by workmen with hammers, in much the same primitive fashion that ice is pounded for the ice-cream freezer in the ordinary American home. The foreman got sick of this primitive process, however, and bethought himself of a bone grinding mill used on a chicken ranch in his neighborhood, which he proceeded to copy. His copy is made of a few simple castings, and consists essentially of a hopper, as shown, having projections on the inside, alternating with similar projections on a revolving cone. The inner surface of the conical hopper and revolving cone taper toward each other, and as the coke passes down through the revolving teeth into this narrowing space, it is crushed finer and finer until it drops through a spout into the box. The fineness can be regulated by raising and lowering the hopper by means of the adjusting nuts on the studs by which it is supported. This crusher is operated by an air motor.

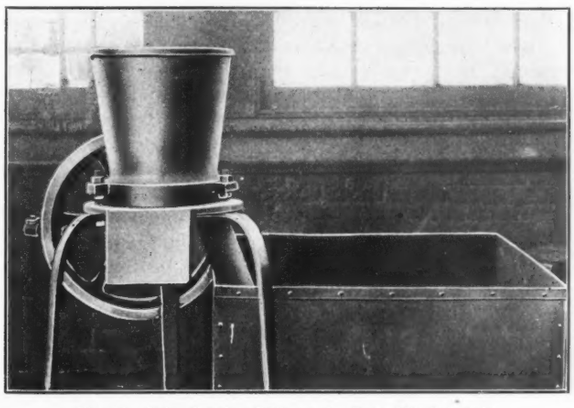


Fig. 16. Coke Crusher Built on the Bone Mill Principle

Finishing Operations on the Radius Rod Extension

Fig. 17 shows the completed radius rod and extension assembled. The remaining machining operations have been performed, as required by Fig. 3, finishing out the slot between the two sides of the fork, and machining them for the tongue and groove joint of the radius rod head. These tongues are made with a taper, as shown, so that they bear on the sides only. When the bolts are tightened down to form the joint, assurance is given of a firm grip with no possibility of play or backlash.

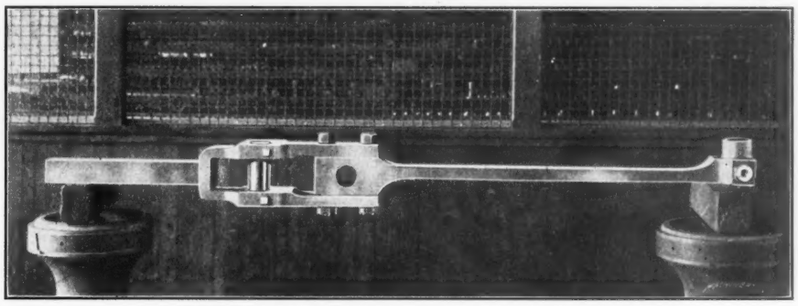


Fig. 17. Radius Rod Extension with Slotting Complete—Assembled with Radius Rod

Another point should be noticed in Fig. 3, which is a regular practice in locomotive construction, but one with which many machine-tool machinists are unfamiliar. This practice is the use of taper bolts. The two bolts shown, which hold the joint, are of 1⅛ inch normal diameter, but they are tapered on the body of the bolt 3/32 inch per foot. This is the standard practice for all important bolts used throughout the whole locomotive. After the holes are drilled, the taper reamer is run through them to such a depth that, when the bolts are screwed home, they will draw in to a tight fit in the holes, and come solidly against the head. Each bolt thus serves as a well-fitted dowel, in addition to its duty of drawing the parts together. When the work is properly made, the joint thus formed is of a superior character.

Roughing Out the Link

A general drawing of the link used for the heavy form of Walschaerts gear is shown in Fig. 18. As was explained in connection with Fig. 1, this is of the kind in which the link

is supported by yokes which are attached to it at each end of the slot, and are provided with central pivots mounted in stationary bearings in the side frames. The two jaws of the radius rod span the link inside of the yokes in a way that will be understood by comparing Figs. 1, 17 and 18. The method of manufacture to be described applies in general to the light form of link shown in Fig. 2 as well as to the heavier type.

The first operation is the simple one of machining the sides of the rough forging from which the link is made. This is done in the planer, with the usual holding devices, as shown in Fig. 19. In Fig. 20 these forgings, which have been finished on each side to the required thickness, are laid out on horses, for marking off with a templet. The further one has the

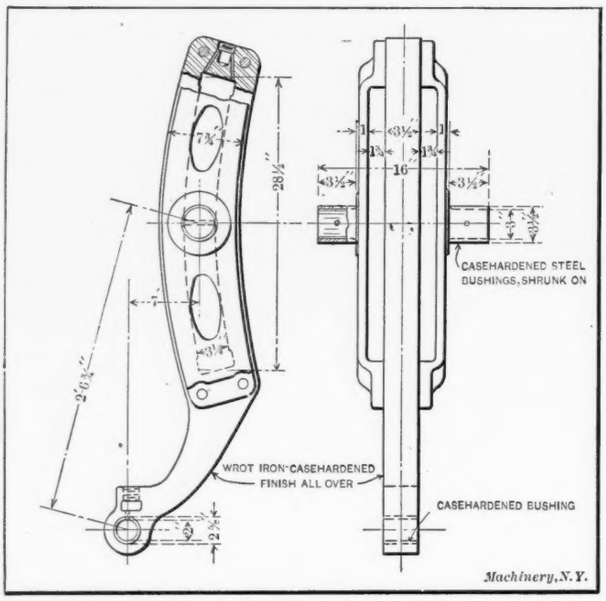


Fig. 18. Link and Mounting used for Heavy Type of Walschaerts Valve Gear

templet clamped to it as shown. From this the outline of the finished piece is scribed, together with the outline of the curved slot for the link block. The location of the pivot for the return crank rod is also indicated, as well as that of the four holes for holding on the yokes. This is an example of standard practice in this shop, where the use of an inexpensive templet saves a great deal of time in laying out work, and

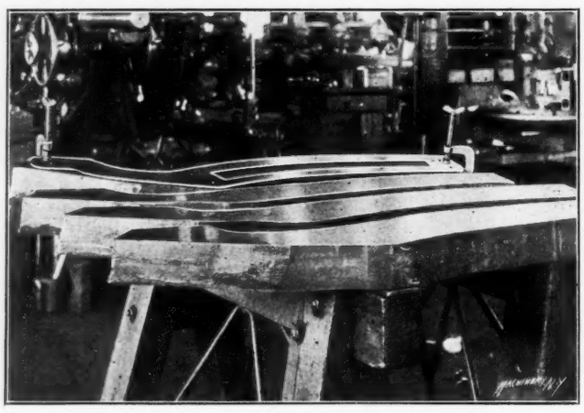


Fig. 20. Laying out the Links with Sheet-iron Templet

gives the assurance of proper location of the various machining cuts.

The slot has next to be worked out. As shown in Fig. 6, the forgings are first drilled through at the ends and in the middle of the slot, one end of the rod boring machine being conveniently employed for the purpose when not otherwise engaged. The links are then taken to the slotting machine, where the stock is roughly worked out by a parting tool as shown in Fig. 21. Two forgings are operated on at a time, with the holes lined up with each other. The parting tool is fed from one hole to the other on each side, removing thin slices of metal from the interior of the slot, and leaving it in condition for finishing to size.

Finishing the Slot of the Link

This finishing operation is performed on a link planing attachment of the usual construction, shown in use in Fig. 22. It would not be necessary to explain this device to railroad men, but for non-railroad readers the accompanying sketch, Fig. 23, will explain the principle. The link, shown at *A*, is mounted on a table *B* with T-slots on the top, which swivels about pin *C* fast in the base *D*. The swiveling of this table is governed by a stud *E* having a roller engaging a swivel guide *F*, clamped to the under side of the ram, or traveling head of the shaper. By setting the guide *F* to the proper angle, it so swivels the work about pivot *C* that the tool *G* will cut to a line closely approximating the true arc of a circle.

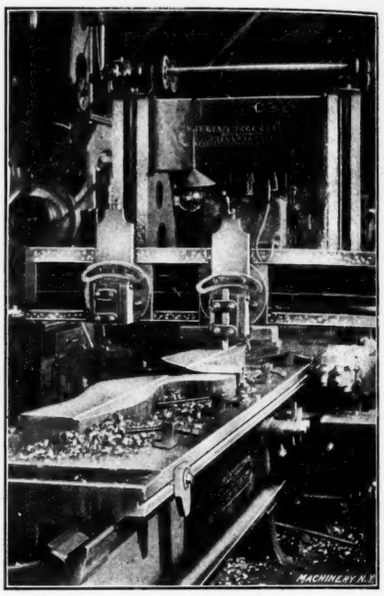


Fig. 19. Planing the Forging for the Links

The diagram Fig. 23 shows the mechanism as applied to the planer rather than to the open-side shaper, inasmuch as it shows guide *F* and tool-point *G* stationary, while the work *A* and work-table *B* are moving backward and forward. The principle is, of course, the same as in the case shown in Fig. 22, where the work-table *B* is stationary and the guide *F* reciprocates with tool *G*, swiveling table *B* and work *A* about stationary pivot *C*. It should be noted that whenever the tool is changed in this attachment for any reason, it must always be set up again with dimension *X* (the distance from the tool-point to the center of the swivel of guide *F*) always the same. If this distance is altered, the radius and position of the arc are changed.

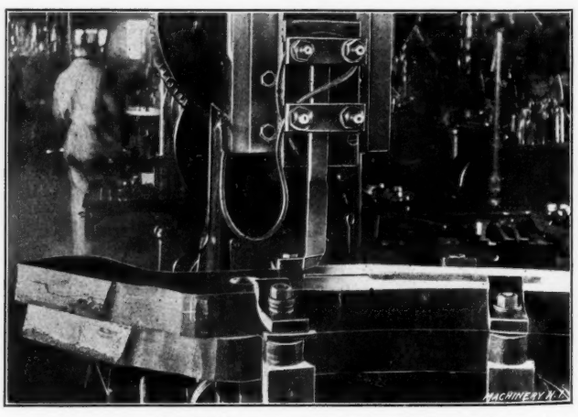


Fig. 21. Slotting the Links Two at a Time after Drilling as in Fig. 6

Inasmuch as the surfaces of the link, thus finished, are approximate and not exactly true, it is customary to finish them more nearly to absolute truth. This is done by grinding on the radius grinder to fit a good bearing with the templet shown in Fig. 24, which is itself accurately machined to the proper radius, and to the proper thickness. It should have been mentioned that the pockets at the ends of the slot have been cut out in a succeeding slotting machine operation to that shown in Fig. 21. These pockets give room for the shaper tool to run out into, as in Fig. 23.

Drilling and Finishing the Link

The slot in the link being the important surface, succeeding operations of importance are located from it. The next thing to be done is the drilling of the holes for the connection with the return crank rod. This operation, which is not shown here, is performed by means of a simple jig, located by a templet fitting the link slot, and carrying a bushing in the proper position for the hole.

The outline of the link has next to be finished. This is

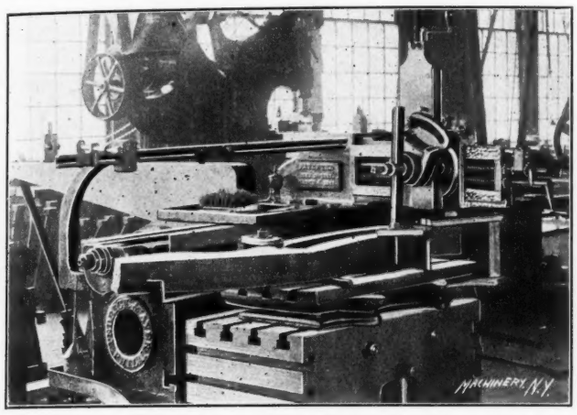


Fig. 22. Planing the Slots in the Links with the Special Planer Attachment

done as shown in Fig. 25 in a vertical milling machine, the table being rotated and fed by hand or power as required, following the outline scribed by the templet. Two links at a time are machined in this way, taking up nearly the full width of the cutter shown in use. They are lined up with each other by a pin through the return crank rod connection hole, and by lining up the sides of the slots.

The oil holes have next to be drilled, and the bolt holes for attaching the yokes. In the case of Fig. 18, the bolt holes are drilled in a way similar to that employed for drilling the return rod connection—namely, by means of a jig carrying a templet which fits the slot, and is provided with a bushing set at the proper relation to the templet. The yokes themselves, shown

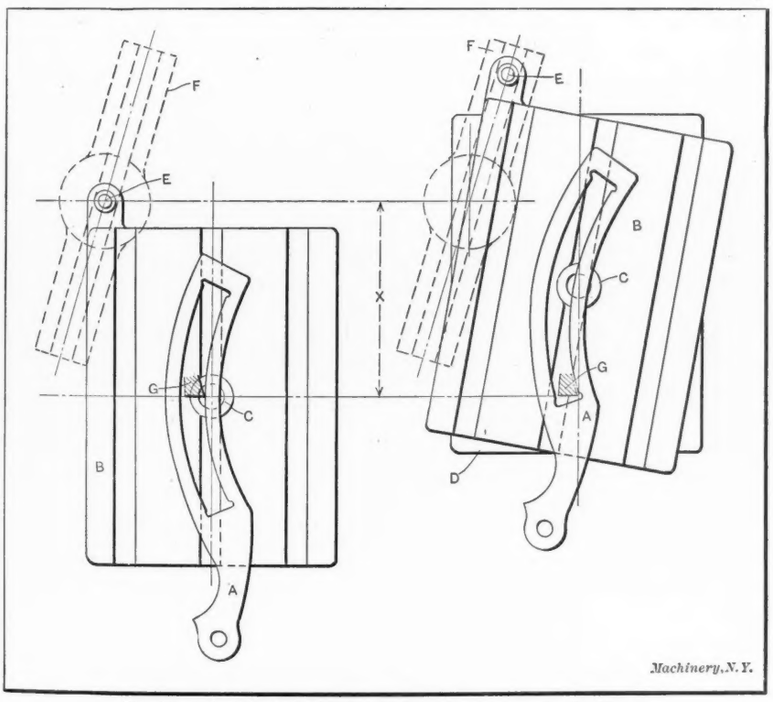


Fig. 23. Principle of Radius Link Planing Attachment for the Planer

in place in Fig. 27, are drilled by a jig which is located from the pivots on which the yokes swing. The holes for holding together the yokes and link are thus so located that the pivots are in the proper position with relation to the slot, and thus are in line with each other as well. These positions and the location of the holes for the return crank rod being the important dimensions, are all located from the slot of each link, and so are in the proper relation to each other.

Fig. 26 shows the method of locating the saddles or pivot supports used for the link on the light type of valve gear shown in Fig. 2. Here a fixture *J* is set into the link slot which fits it snugly, and is provided with pockets for receiving the saddles *H*, which are thus accurately located from the journals of the pivots. When thus located each is held in place by a set-screw as shown. The whole attachment is now slid along through the slot until it makes contact with the distance piece *K*, which is mounted on a stud fitted in the return crank rod hole. By this means, the pivots are located as they should be, with proper reference to the slot, and with proper reference to the return rod connection.

After the yokes in Fig. 27 and the saddles in Fig. 26 have been drilled and bolted into place, the outlines of these members are finished off to match evenly with the outlines of the link, making a good smooth job. Figs. 27 and 28 show a com-

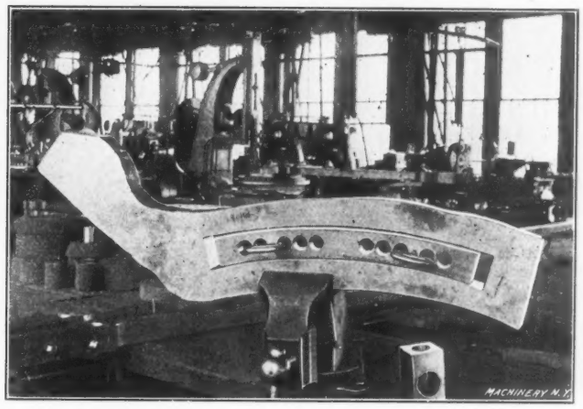


Fig. 24. Templet used for Finishing the Slot in the Link to accommodate the Radius Rod

pleted link of the heavy type, with the block in place ready for assembling in the locomotive.

Manufacturing Methods in Locomotive Building

Locomotives are built at Altoona on a manufacturing basis. When we make this statement, the words "manufacturing basis" mean something different than they do when we say that typewriters or machine tools are so built. In fact the term has a different meaning for all three cases. Manufacturing methods in building locomotives do not involve the use of jigs and fixtures for finishing all the massive parts of which the great machine is built. Jigs and fixtures large enough to do this would be prohibitive in size and cost, and practically no advantage would be gained from their use in any event.

The "manufacturing basis" on which the locomotive is built involves the use of templets for laying off all important outlines, holes, etc. Comparatively few holes are drilled in jigs, those so drilled being mostly the ones on which the accuracy of the valve gear lay-out depends, such as the radius rod and yoke connections in the link we have just described. In locomotive manufacture large use is also made of fixed gages for all the vital measurements of the frame, axles, etc., and for such other parts as are likely to require renewal. These parts are thus practically made on the interchangeable plan, though no such extreme of refinement is needed as that necessary in making typewriter parts interchangeable.

It will be seen that the tools required for this manufacturing work are of the simplest possible nature. The templets are made of sheet iron; the gages are made from bar steel, drawn down and ground at the points to the proper dimensions; and the fixtures are, in general, of a rugged and simple construction. By following this plan, the expense for tools is of comparatively small importance, even when building only

two or three locomotives of a kind. At the same time advantage is taken of about all the benefits of accuracy and interchangeability which can be secured on such large work.

The New K-2 Pacific Type Locomotive

It may be interesting to give a few particulars of the locomotive shown in Fig. 1. This is, as may be seen, of the Pacific type, which has come to be a standard machine for hauling the heavier high-speed passenger trains. The Pennsylvania R. R. has hitherto been able to maintain the schedules on its passenger runs with locomotives of the Atlantic type (see Fig. 2) of considerable lighter weight than other roads had found necessary for the same purpose. It was decided, however, a short time ago, to experiment with heavier machines, and the K-2 locomotive shown herewith is the result. This is probably the heaviest passenger locomotive ever built, outside of the Mallet articulated machines furnished to the Santa Fé, which are in a class by themselves.

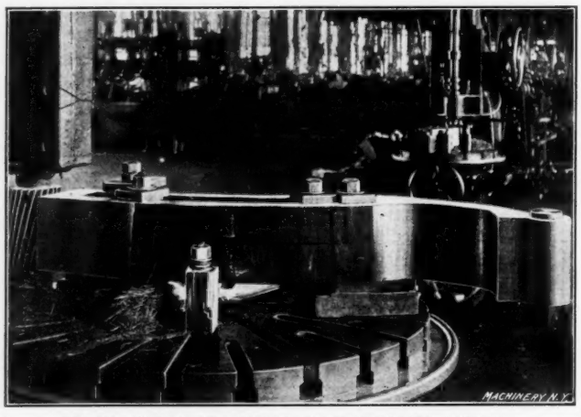


Fig. 25. Outlining the Links in the Vertical Milling Machine

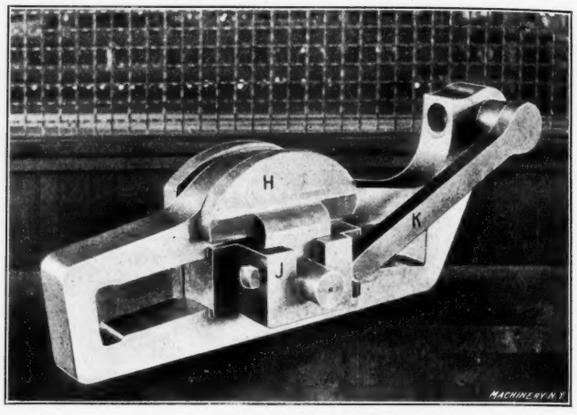


Fig. 26. Jig used for Locating Pivot Saddles on Atlantic Type Link

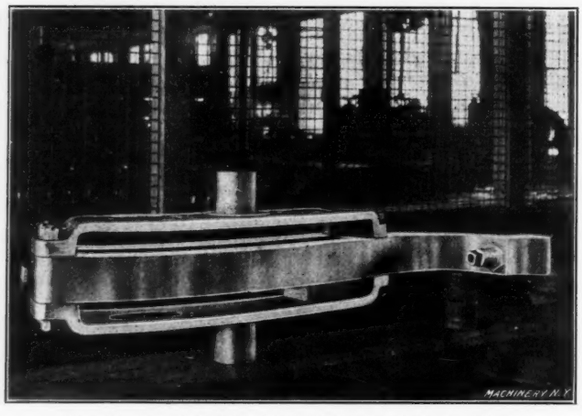


Fig. 27. Complete Pacific Type Link with Yokes in Place

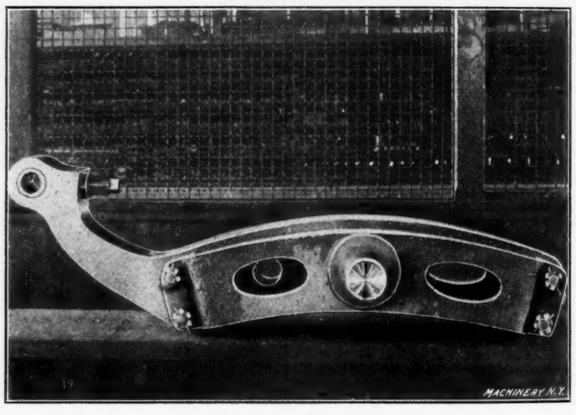


Fig. 28. Another View of the Finished Pacific Type Link

The total weight of the engine alone is 270,000 pounds, of which 176,500 pounds are on the driving wheels. The wheels are 80 inches in diameter. A straight boiler is used 80 inches in diameter at the front end. The grate area is 61.8 square feet. The total heating surface is 4427 square feet. The cylinders are 24 inches in diameter with a 26-inch stroke. The total cylinder horsepower developed is something over 2000, giving about 134 pounds weight per horsepower for engine and boiler. Comparison with any figures which might be taken from stationary practice of similar size would show a tremendously higher ratio than this, giving a good idea of the high degree of specialization which has been reached in locomotive design.

The diameters of the wheels and boiler are so large that even the liberal clearance allowed by the Pennsylvania R. R. have necessitated the shortening of the stack and domes to an unusual degree. On some roads, like the New Haven or the Boston & Albany, everything would be sheared off clean from the top of the boiler the first time the engine ran under a highway bridge. The engine does not show its size in the picture on account of the large diameter of the driving wheels and high clearances allowed. The writer saw it on the testing plant and there it looked imposing indeed. The experiments with the first example of this kind have been so satisfactory that a number are being built for service on various sections of the road, east and west of Pittsburg, with the idea of giving them a more extended trial.

* * *

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION CONVENTION

The sixth annual convention of the International Railway General Foremen's Association was held at the Grand Hotel, Cincinnati, Ohio, May 3-7. C. H. Voges, of the Big Four, Bellefontaine, Ohio, was elected president and L. H. Bryan, Duluth & Iron Range Ry., Two Harbors, Minn., was re-elected secretary-treasurer. A number of interesting papers were read and one of the star events was a talk on the apprenticeship question, by Prof. Herman Schneider, of the University of Cincinnati. Three important committees were appointed to prepare reports, for the next convention, on: Methods of Shop Organization; How Can Shop Foremen Best Promote Shop Efficiency, and Why Should the Press Fit of the Axle be Larger than the Journal; the respective chairmen being D. E. Barton, Santa Fé, Topeka, Kans.; F. C. Pickard, C. H. & D., Indianapolis, and Stephen Motta, Nat. lines of Mexico, Aguascalientes, Mexico.

About sixty supply men had machines and samples on exhibition. The next, or seventh, annual convention will be held in Chicago.

* * *

It is stated in the *Electrical World* that of the 5,000,000 horse-power actually represented by the Niagara Falls, only about 5.5 per cent, or about 270,000 horse-power, has been thus far utilized. Of this, 126,000 horse-power is employed in electro-chemical processes, 56,000 horse-power for railway service, 36,400 horse-power for lighting, and 45,500 horse-power for various industrial services. Nearly 125,000 horse-power is transmitted to points more than ten miles from the falls. Of this amount 12,300 horse-power is transmitted over a distance of more than 100 miles, while 33,500 horse-power is transmitted between 75 and 100 miles.

HARDENING OF CARBON AND LOW-TUNGSTEN STEELS

A research on the hardening of carbon and low-tungsten tool steels has been conducted by Mr. Shipley N. Brayshaw of Manchester, England, and the results of his investigations were presented to the Institution of Mechanical Engineers at the April 15, 1910, meeting. Some of the conclusions arrived at in these investigations are of general interest to all who have to do with the hardening of steel and the effect of this process on its structure, cutting capacity, and strength.

The paper deals exclusively with the results obtained from two kinds of carbon tool steel that, except for minute variations, differed only in the fact that one of them contained about 0.5 per cent of tungsten. The steel contained on an average of 1.16 per cent carbon, 0.15 per cent silicon, 0.36 per cent manganese, 0.018 per cent sulphur, and 0.013 per cent phosphorus. The whole work of investigation was devoted to questions directly connected with machine shop hardening, with the aim in view of throwing light on the many problems met with in daily practice.

Hardening Temperatures

The hardening point of both low-tungsten and carbon steel may be located with great accuracy, and the complete change from soft to hard is accomplished within a range of about 10 degrees F. or less. After the temperature has been raised more than from 35 to 55 degrees F. above the hardening point, the hardness of the steel is lessened by further increases in the temperature, provided the heating is sufficiently prolonged for the steel to acquire thoroughly the condition pertaining to the temperature. There is a "change-point" at about 1615 degrees F. in low-tungsten steel and at a somewhat higher temperature in carbon steel. One of the several indications of this change-point is the shortening of bars hardened in water at temperatures below that point, whereas the bar lengthens if this temperature is exceeded at the time of quenching. Practically the same results are obtained by heating low-tungsten bars to any temperature from 1400 to 1725 degrees F. and quenching in oil, as by quenching in water.

Length of Time of Heating

Regarding the effect of heating to various temperatures for various lengths of time before quenching for hardening, the following conclusions are drawn: Prolonged soaking up to 120 minutes at temperatures at which the hardening change is half accomplished in 30 minutes, does not suffice to complete the change. Prolonged soaking for hardening at a temperature of 1400 degrees F. has a slightly injurious effect on the steel, but does not materially influence the hardness. At a temperature of about 1490 degrees F. a great degree of hardness is attained by quick heating, but the hardness is impaired with 30 minutes soaking. Prolonged soaking for hardening at a temperature of about 1615 degrees F. has a seriously injurious effect upon the steel. A specially great degree of hardness may be obtained by means of soaking at a high temperature, such as 1615 for a very short time, but even as long a time as 7½ minutes is long enough to seriously impair the hardness.

The temperature of brine for quenching is of considerable importance. Both low-tungsten and carbon steel bars quenched at 41 degrees F. were decidedly harder than bars quenched at 75 degrees, and quenching at 124 degrees F. rendered the bars much softer.

Effects of Previous Annealing

The method of previous annealing affects the hardness of steel considerably. The elastic limit of low-tungsten bars hardened at either 1400 or 1580 degrees F. varies according to the annealing they have undergone. The elastic limit is high after annealing at about 1470 degrees F. for 30 minutes, or 1290 degrees F. for 120 minutes, but it is seriously impaired by annealing at 1470 degrees F. for 120 minutes. If low-tungsten steel is annealed at 1725 degrees F. and hardened at 1400 degrees F., the elastic limit is inferior, and the adverse effect of the previous annealing is much more pronounced if the hardness is done at 1580 degrees F. The elastic limit of carbon steel annealed at any temperature between 1290 and 1725 degrees F. and hardened at either 1400 or 1580 degrees F. does not vary by nearly such great amounts as the elastic limit of the low-tungsten bars, and the highest annealing temperature given above is not injurious so far as the elastic limit is concerned.

The hardness of low-tungsten bars hardened at 1400 degrees F. decreases from a high scleroscope figure to a low one as the temperature of annealing increases from 1290 to 1725 degrees F. The hardness is increased by prolonging the annealing at the lower temperature. The hardness of low-tungsten steel hardened at 1580 degrees F. is fairly constant at a moderately high scleroscope figure, whatever the temperature of annealing.

Effect of Heating in Two Furnaces

An interesting part of the experiments relates to the use of two furnace heats for hardening, heating the steel first in one furnace to a certain temperature for a given time, and then immediately, without cooling, soaking in a second furnace at a known temperature and for a definite time. These experiments show that low-tungsten and carbon steel bars heated for half an hour to temperatures between 1545 and 1650 degrees F. are not much affected so far as their elastic limit and maximum strength are concerned by a further immediate soaking for half an hour at 1400 degrees F. If, however, the temperature in the first furnace is 1725 degrees F., the low-tungsten steel is much improved by a further soaking at 1400 degrees F., but the carbon steel is much injured by the same treatment. Bars of low-tungsten steel heated for 30 minutes at 1616 degrees F. and then soaked at 1332 degrees F. for a further 30 minutes, give a high elastic limit and maximum strength, and are harder than if the second soaking were at a temperature of 1400 degrees F. The carbon steel, again, is but little affected by these variations in the second furnace.

The change of length in hardening, however, of both low-tungsten and carbon steel is much affected by the above variations in the temperature of the second furnace. Good results as regards elastic limit and maximum strength, and also as regards hardness, are obtained by very short soaking, first at a high temperature, say 1615 degrees F., and then at a low one, the results being best when the second temperature is near to or a little below the hardening point. If the furnace be at a sufficiently high temperature it is easy either by variations of the temperatures of the two furnaces, or by variations in the time of soaking, to arrive at a treatment of the steel, both low-tungsten and carbon, whereby they neither lengthen nor shorten. Under the same treatment carbon steel has a greater tendency to shorten than low-tungsten steel.

Miscellaneous Results

Other experiments showed that low-tungsten steel heated to 1580 degrees F. for 15 minutes and quenched in oil has a higher elastic limit and is harder than carbon steel similarly treated. As regards annealing, it was found that bars annealed at a temperature of 1470 degrees F. or below became slightly shorter by the annealing process, and its action was more pronounced in the case of carbon steel than tungsten steel. Annealing at a temperature of 1650 degrees F. causes both low-tungsten and carbon steel to lengthen.

It was found that recalescence of low-tungsten steel takes place gradually at a temperature of 1348 degrees F., and more readily at 1337 degrees F., and further that the recalescence at either of the above temperatures is very much retarded if the steel is cooled from a maximum heat of 1634 degrees F.

Regarding hardening cracks, it is shown that both for low-tungsten and carbon steel, such treatment as produced the highest elastic limit accompanied by the greatest hardness is frequently the most risky. The risk of hardening cracks is reduced if the steel is heated for a sufficient length of time to a temperature of 1650 degrees F. or a little above. Low-tungsten steel is more liable to crack in hardening than is carbon steel.

Effect of Tempering

Tempering experiments showed that little effect was produced by the tempering of carbon steel to 300 degrees F. for 30 minutes. Tempering the same steel to 480 degrees F. for 15 min-

utes, however, caused it to soften considerably and to shorten in length. For low-tungsten steel the elastic limit was increased considerably by tempering up to a temperature of 480 degrees F. The maximum strength of the same steel coincides with the elastic limit for bars either untempered or tempered at 300 degrees F. for 15 minutes, but it then rises rapidly with further tempering. The hardness, as measured by the scleroscope, was considerably reduced by tempering at 300 degrees F. and still more at 390 degrees F., but was not so much affected by further tempering at 480 degrees F. The length of the low-tungsten bars was reduced by tempering up to a temperature of 480 degrees F.; the higher the temperature, the greater was the reduction in length.

Effect of Tensile Strength

The following conclusions refer to low-tungsten steel, but there is no reason to doubt that they are also applicable to carbon steel. A variation in the hardening temperature of only 9 degrees F., the extremes being respectively above and below the proper hardening temperature or decalescence point, has a tremendous influence on the extension under load, but the maximum strength of the bars so treated did not differ much. A very good bar was produced by quenching from a temperature fully 108 degrees above the hardening temperature. A heat of only 5 minutes' duration produced a harder bar than a heat of 25 minutes, the maximum temperature in both cases being 1470 degrees F., or a little above; but the bar heated for a shorter time gave a much lower elastic limit. The maximum strength alone is not necessarily any indication of the condition of the steel in question, or of the treatment to which it has been subjected; nor is the hardness alone necessarily an indication of the condition of the steel or the treatment.

The following conclusions refer both to tungsten and carbon steels. Tempering up to a temperature of 570 degrees F. gradually increases the maximum strength and the elastic limit, although some irregularities enter which have not been fully accounted for. Tempering to this temperature reduces for a given stress the extension under load and the permanent extension.

Conclusion

In conclusion it may be stated, that these experiments show that steel of the quality treated in these experiments may be hardened within a temperature range of about 215 degrees F. The lower end of this range is very sharply defined, but the highest temperature allowable is difficult to determine, and as far as the appearance of the fracture is concerned there is little evidence of improper hardening until the temperature of the proper hardening point has been exceeded by 270 degrees F. So wide in effect is the margin of allowable variation for hardening that when the hardness is decided by the appearance of the fracture alone, any workman of average skill can easily keep within the limits and judge the temperature by sight alone, and as a matter of fact this is being done all the time in the manufacture of such articles as pocket knives, small files, etc., which are hardened by the thousands with practically no waste. But, of course, it must not be understood that articles so hardened reach anything like their maximum efficiency, because even small variations in the heat treatment previous to the quenching have a pronounced effect upon the condition of the steel, and even the previous treatment, such as the annealing to which the steel has been subjected, may influence the final result.

While it is thus easy to harden so as to obtain reasonably *good* results, the production of the *best* results given necessitates a degree of accuracy which can never be obtained by sight alone, and it is also important to notice that the difference between good hardening and the best hardening is very great.

As an example may be mentioned the hardening of razors. It is sometimes said that whatever price one pays for a razor, the buying is a game of chance. Occasionally one hears of a remarkable razor that holds its edge as if by magic, while others of the same make and type may not be anywhere near as good. All of them, however, would show to the eye practically the same fracture, and apparently seem to have been treated in the same way. The experiments referred to above, however, indicate that there may have been a slight difference in the hardening temperature and consequently in the subsequent condition of the steel, and also that it would be possible to harden every razor in a gross so that each one would be truly a duplicate of the best. The same, of course, holds true of a great number of other tools.

The author concludes by saying that there have, for some years past, been efforts of steel makers to discover new alloy steels, and splendid success has been obtained in this direction, but there is still a wide field for the steel users for discovering the best use of the material already known. It is of little avail that occasionally tools show marvelous results, unless the hardener can at any time produce the same results with the same steel. The time is likely to come when all the factors in the hardening of tool steel will be controlled with accuracy within predetermined limits, and any failure may be investigated and the cause located with as much certainty as if a mistake had been made in the machine shop.

* * *

FROGS, SWITCHES AND CROSS-OVERS*

As a rule, men who are primarily interested in machine construction are, for obvious reasons, not very well informed on track work. It often happens, however, that draftsmen, superintendents and others who have no training in this class of work are required to lay out, approve, or order industrial track systems to be used inside of a machine shop or in the yards outside. It is then necessary to decide upon the various details in connection with the frogs and switches, and some elementary information relating to this work will undoubtedly be of value to any man who is, or expects some day to be placed, in a responsible position where he may be occasionally called upon to carry out work of this character.

Switches are used for leading the wheels of cars from the main track onto a turn-out track. It is evident that when the outer switch rail reaches the opposite main rail, the wheel flange must pass through the main rail. The device by means of which the rail of the turn-out curve crosses the rail of the main track is called a frog, the general appearance of which is as shown in Table I of the accompanying Data Sheet Supplement. Frogs are made of various dimensions, determined by the angle of the frog, that is, the angle which the main rail gage line makes with the turn-out rail gage line at the point where these lines cross each other. Frogs of different angles are known by numbers, and a table is given in the accompanying Supplement of frog numbers with their corresponding angles, the numbers being given from 1½ up to 20. Formulas are also given by means of which the frog number can be found when the angle is known, and the angle found when the frog number is known. As shown in the Data Sheet, dimension L is the length along the center line. This is, theoretically, the correct dimension to be measured for determining the frog angle. In practice, however, the length is usually measured along the gage line, because of convenience in taking the measurement in this way. As the angles are small, approximately correct results are obtained by inserting the dimension thus obtained in place of L in the formulas.

A circular turn-out is shown in Table II of the Data Sheet. In the illustration the various dimensions, such as theoretical lead, actual lead, radius, etc., are defined, and formulas for finding each are given. When a turn-out of this kind is being laid out, the angle can be determined when the radius and the gage are known, and when the angle has been found the corresponding frog to be used, as defined by its number, is determined from the table already referred to. The lower part of Table II gives formulas for a turn-out using straight frog and switch. In this case the formulas are somewhat more complicated than in the simple circular turn-out.

In Table III is shown a diagram of a three-throw turn-out, and formulas are given for determining the angle between the outer rails of the two turn-out curves. In the lower part of the same table is a diagram of a double cross-over with straight crossing and curved switches, and also for a double cross-over with reverse curve, formulas for the required angles and dimensions being given for both. In Table IV some of the dimensions which can be found by

* With Data Sheet Supplement.

the formulas given in the previous tables have been tabulated and collected for six different gages. These tables give the radius in feet, the angle in degrees and minutes and the theoretical lead in feet and inches. A special table for 4-foot 8½-inch, or standard gage, is also included, which gives the number of frog, the corresponding angle, the theoretical lead, the radius of the turn-out curve and the degree of the curve.

The expression "degree of curve" may require some explanation to persons not familiar with railroad track work. The degree of a curve is the center angle that would be subtended by a chord 100 feet long. For curves from 1 to 10 degrees the radius may be found by dividing 5,730 feet, which is the radius of a one-degree curve, by the degree of the curve. The results are sufficiently accurate for all practical purposes, but for sharp curves, that is, for those exceeding 10 degrees, the following formula should be used:

$$R = \frac{50}{\sin D}$$

in which R = the radius of the curve, and
D = the angle of the curve in degrees.

It is evident that the degree of a curve has nothing to do with the length of the arc of the curve, but merely with the length of the radius. The shorter the radius, the greater the degree of the curve. The last-mentioned table may be used for finding the corresponding dimensions required for the use of a frog of a certain number, or it may be used for finding the required frog when any of the other dimensions are given. As the tabulated data in Table IV give the dimensions for the most commonly occurring conditions, it will save considerable calculation in laying out frogs and switches.

* * *

The gold production in 1909 exceeded that of 1905 by $15,000,000. The total amount of gold mined is valued at over $450,000,000, of which the United States furnished about $100,000,000, Africa $170,000,000, and Australasia $72,000,000.

DRAFTING-ROOM OF THE TAFT-PEIRCE MANUFACTURING CO.

The Taft-Peirce Mfg. Co., located at Woonsocket, R. I., has recently refitted its drafting department, and now has a model drafting-room and equipment. This company is unique in New England in the respect that a very important feature of its business is the development of new inventions from ideas furnished by inventors and their promoters. Work of this character renders essential a highly organized engineering force, and to provide this force with adequate and suitable quarters the company established the conveniences described.

Two things are of prime importance in a drafting-room, the lighting and the drafting tables. If the best work is expected, the draftsman must have a good table for his work, as well as adequate light, properly distributed. In the case of the Taft-Peirce Mfg. Co., the lighting has been provided for by placing the room in a second-story wing, thus affording natural lighting on three sides through large windows located at even intervals which make the wall space about equal in width to the window. The artificial lighting is provided for by Cooper-Hewitt mercury vapor lamps hung from the ceiling and by tungsten drop lights, two for each table. The drop lights are all at a fixed height, and remain in that position at all times. It is expected, however, from what has already been learned by use that the drop lights will probably be dispensed with and that the vapor lamps will be sufficient for all artificial lighting. The walls and ceiling are painted with white enamel waterpoof paint, which can be wiped clean, and which does not absorb light.

Drafting-room of the Taft-Peirce Manufacturing Co.

The tables, which are the most striking feature of the equipment, were built by the Washburn Shops of the Worcester Polytechnic Institute. An illustration and description of this table was published in MACHINERY, November, 1909. Each table is provided with an automatic releasing and locking rise and fall device which permits tilting to any angle,

between the horizontal and the vertical planes. The table top is provided with a parallel ruler, as will be seen in the installation shown; if desired, a drafting machine can be readily attached. In the installation shown the table tripods are screwed to the floor, a light shelf is attached to the rear of the tripod posts, and is used to lay handbooks, extra drawings and tools upon. With the automatic rise and fall device, it has been found more convenient to raise or lower the table top to or from the drop light than to adjust the cord, and the absence of loops or adjusting devices in the cords greatly improves the appearance of the room.

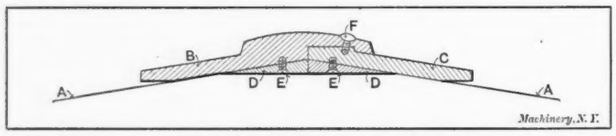
Toilets, wash- and coat-rooms are provided. It will be noted that each draftsman wears a white laundered coat. The blueprinting equipment consists of a continuous blueprinting machine using Cooper-Hewitt lamps. As the printing room is above the level of any nearby roofs, sun printing can be readily accomplished if desired. In taking the photograph for the illustration the camera was set up near the chief draftsman's office which occupies a corner of the main room. This office is provided with the necessary equipment for a complete system of indexing, comparing and cost-keeping so essential in engineering drafting.

* * *

THE TRANSMISSION OF POWER BY STEEL BELTS

In a paper on the transmission of power by belts, recently read by Mr. R. Krall before the British Institution of Engineers, a number of interesting details regarding the transmission of power by steel belts were given. The use of steel belts for power transmission is a recent development, being thus far mostly applied in Germany and Belgium, and has previously been referred to in MACHINERY in the February, 1908, issue, engineering edition.

The thickness of the steel belts varies from 0.2 to 0.9 millimeter (0.008 to 0.035 inch) and the width of the belt varies from 22 millimeters to 200 millimeters (⅞ inch to 8 inches). For a 200-H. P. drive at a given speed, for example, one belt 6 inches wide by 0.024 inch thick is used. For a 440-H. P. drive at the same rate of speed, again, two belts are used, each being 6 inches wide by 0.027 inch thick. One of the first difficulties met with in the production of steel belts was that of producing a perfectly homogeneous metal. The material for the belts now is made of specially manufactured steel of high tensile strength. Another difficulty met with has been the proper construction of the joint between the ends of the belt. An ideal drive would, of course, be obtained by the employment of a continuous steel band, but there are many difficulties in the way of the production of such a belt and its cost would be prohibitive. It would be more difficult to handle and transport, and would often present great difficulties in mounting on the pulleys. A joint as shown in the accompanying illustration is, therefore, adopted. The belt is soldered to the joints at the factory, and the user, when putting the belt in place, has only to insert a few screws. In the illustration, *A* indicates the steel driving belt, *B* and *C* are the two halves of the joint, and at *D* are shown two small triangular filling pieces. Two rows of small screws *E* secure these triangular pieces to the belt and to locking pieces *B* and *C*. At *F* is indicated a row of larger screws uniting the locking pieces. All that has to be done when putting the belt in position is to insert the screws *F*.



Construction of Joint for Steel Belts

It will be noticed that the locking pieces are prolonged for a considerable distance beyond the joint proper. This construction is the result of experience, as it was discovered that when this additional length of the locking pieces was not provided the belt broke near the small triangular pieces *D*. A small curve is provided on the under surface of the joint, but it is very slight, the joint being nearly flat. In order to predetermine the length of the belt a special apparatus is used by means of which a light tape of steel is placed over the pulleys and subjected to a predetermined tension, the two ends being drawn together and permitted to overlap. Both ends are then cut through at the same point and a band the exact length of the required belt is obtained. The manufacturers make the length of the belt to this gage.

The steel belts run fairly well on smooth cast iron pulleys, but after a time there is a tendency to polish the surface of the pulleys and it has been found desirable to cover them with a thin cork covering which is glued to a piece of canvas which, in turn, is cemented to the pulleys. There is practically no slip whatever on pulleys treated in this way, and the cork covering does not wear away.

Tests undertaken at the Charlottenburg University with these belts indicate that it is the best practice to use an initial tension of 10,000 pounds per square inch of section of belt. The belts were run in these tests at velocities ranging from 3000 feet per minute to 7000 feet per minute, and the percentage of slip varied from 0.036 per cent to 2.2 per cent, the average being about 0.55 per cent.

Although this method of driving by steel belts is too new to have fully established its claims, some thousands of steel belts are already in use, and no doubt the system must be regarded as having an important future. According to figures published by the manufacturers of the steel belts, a steel belt 4 inches in width will transmit the same power as an ordinary leather belt 19 inches wide, or as 6 ropes with 1¾ inch diameter each. The weight of the driving pulleys as compared with those for leather belting is but one-half, and as compared with those for rope drive is hardly more than one-quarter. The total cost of steel belting installed is stated to be 60 per cent less than that for leather belting, and 33 per cent less than that for rope driving, while the loss of power through slippage is almost negligible with steel belting. Steel belts, therefore, appear to have some considerable advantages over those of other materials. They do not stretch, and therefore never have to be taken up. Very high speeds, up to 10,000 feet per minute, may be employed. The belts apparently do not wear, due to the fact that they do not slip. Short drives may be used, and the pull on the bearings and the consequent wear is reduced on account of the decreased weight of pulleys.

On the other hand, the material in the steel belts may not prove as reliable, although this point is speedily being remedied, and it can be added that steel belts have been in continual successful use for over two years. Another consideration is that unless properly guarded these belts would be extremely dangerous if failing when running at a high speed, and the necessity of having to be extremely careful about the exact length may sometimes prove troublesome. The belt must be extremely well applied to insure that the power is evenly distributed over the full width of the steel band, as otherwise excessive stresses would be set up at one edge, and the belt would then be stressed at this point beyond its breaking strength with the result that the whole belt would fail.

* * *

Attention is called in the *Zeitschrift des Vereines deutscher Ingenieure* to the development in the building of motors for airships and aeroplanes. It is stated that the Daimler-Motoren-Gesellschaft, Untertürkheim, Germany, in 1890 built a 5-horse-power motor for an airship, the weight of which was seventy pounds per horse-power. This year the same company has built a 115-horse-power motor for a flying machine in which the weight per horse-power is only 4.8 pounds. It will be remembered in this connection that the weight per horse-power of the Adams-Farwell aeronautic gasoline motor, described in the engineering edition of MACHINERY, July, 1908, is only 2.7 pounds per horse-power.

* * *

The Santos-Dumont new monoplane flying machine, which is fitted with wheels driven by the engine, so that it can run on the road as well as fly, and which weighs complete only 242 pounds, is being built by the French Clement Co., and sells at $1,250 each. This price apparently brings the flying machine into direct competition with the automobile.

WOODEN DRAWINGS

By W. H. SARGENT*

The boss patternmaker had put a bit into an upright drill and was boring furiously into a block of wood. "What are you making, chips?" I asked. "No, I'm making a wooden drawing," he replied. "You see, here is the blueprint of a pattern. It needs four views to show the thing up. The back side view is projected on an angle to show a diagonal brace and it is all covered over with dimensions, until no man in the shop can read it. Now I am trying to rough out something which will show the shape so that a man will know just what he is trying to do. It isn't a model, nor a pattern. It is something to work by the same as a paper drawing, so I call it a wooden drawing."

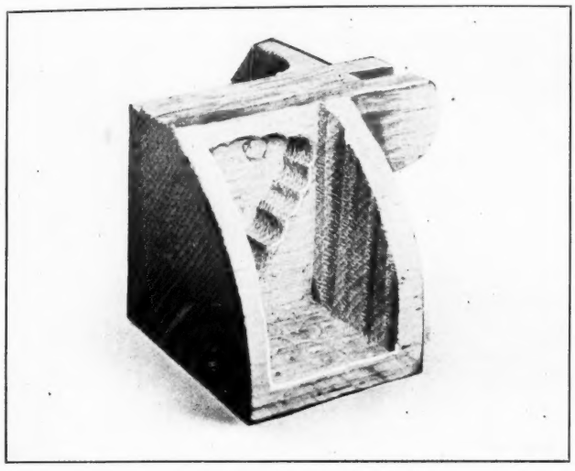


Fig. 1. Example of a Wooden Drawing

He handed me the article shown in Fig. 1 which he had grubbed out. The drawing was quarter size and he had made this the same. It was roughly done, being made entirely with a saw and a bit, but it showed what was wanted, and left nothing to the imagination.

Fig. 2 shows a "wooden drawing" of a portion of a 200-ton scale of new design. Rough as this was, it helped astonishingly to give one the sense of proportion. Instead of a number of confusing drawings, more or less incomplete and all on a flat surface, here was in effect the full-sized machine, showing not only the strength and symmetry of the various parts but their weaknesses as well. Careful examinations were made by different men to determine the handiness and accessibility of the various parts and a full discussion was held to consider the general appearance of the design.

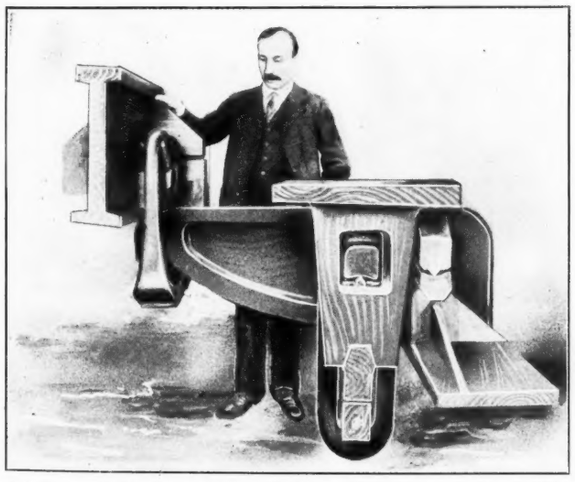


Fig. 2. Wooden Drawing of Part of the Mechanism of a 200-ton Scale

No paneling was done. The model was painted a dull lead color and the effect of sunken parts was done with darker paint on a flat surface similar to Fig. 3. Perhaps none of the men concerned in getting up this scale were able to comprehend from the drawings exactly how it was going to look; whether there would be freedom enough between certain parts or whether certain other parts would interfere with each other, yet all these points were satisfactorily decided from the model without the expense of an elaborate set of patterns and core-boxes or the aid of heavy castings with pivots set to a gage. The design was accepted with but very few changes. Fig. 4 shows this part of the scale somewhat modified and as finally completed and erected.

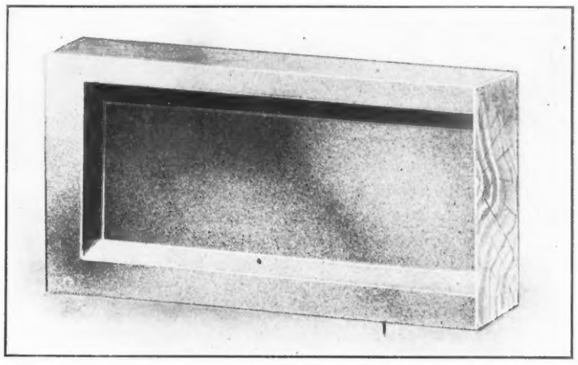


Fig. 3. The Wooden Drawings are not panelled, Sunken Effects being obtained by Shading

A certain bridge company spent $600 to construct a full sized model of a panel point for the purpose of familiarizing their own men with the details of the work and of impressing others with its importance and magnitude—a large price for something which has no commercial value. The question arises—does it pay to put so much money into something which can neither be sold nor used? Of course it pays; in these days of commercial rivalry anything pays which enables one to find the answer before the other fellow gets his pencil sharpened. There is no question about the commercial value of good appearances. A "good front" is a distinct financial asset, whether on the salesman or on the goods. No matter

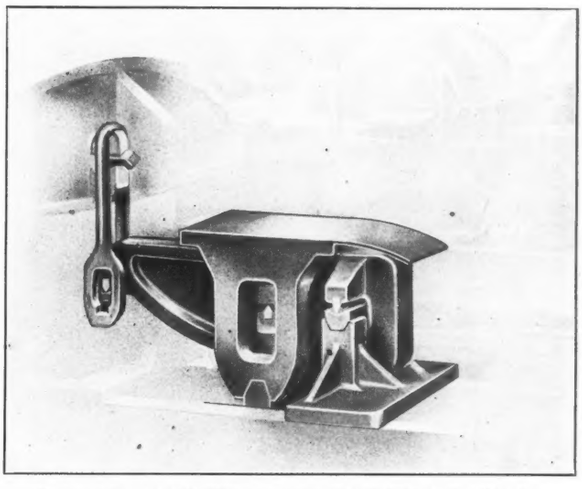


Fig. 4. Completed Design of Part for which Preliminary Wooden Drawing, Fig. 2, was made

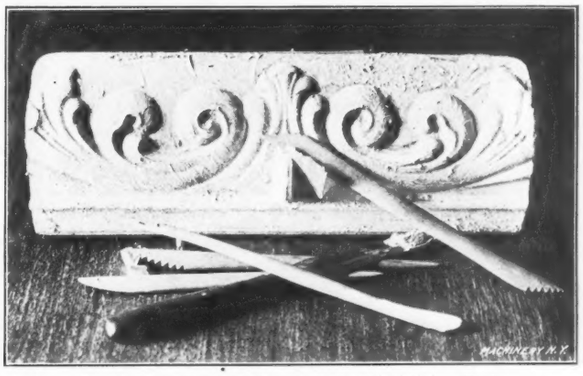


Fig. 5. Clay Model of Scroll Work and Modeling Tools

* Address: St. Johnsbury, Vt.

how good the old machines were, the new ones are better if only "just as good," and this isn't as Irish as it may seem, because while some of the old machines may still do good work, yet their misproportions were so disguised with moldings and covered with curling curves and required so much "manicuring" that their total product was materially less than the plain and simple machines of to-day. Ornament has its place but it should not be used to disguise poor construction. "The beautiful is often as useful as the useful" and designers of the beautiful make more frequent use of preliminary models than designers of the useful. In most cases they use modeling clay, building up the design with their fingers and working out the details with the small wooden tools shown in Fig. 5.

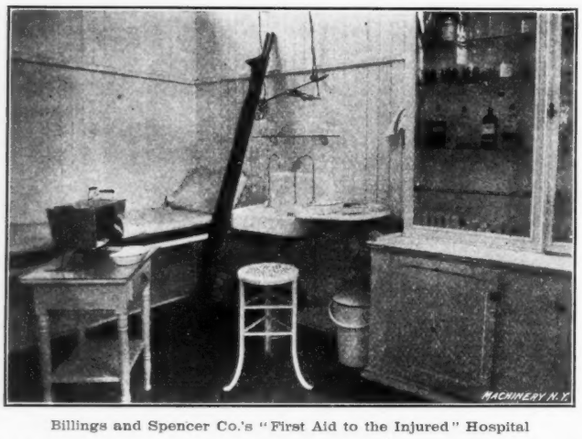
While paper drawings are necessary, "wooden drawings" are also helpful in showing which points to emphasize and what to disguise. The Lord didn't make man with the ribs in sight but added flesh to make "the human form divine," so it is up to the draftsman to assemble the mechanical elements—the dried bones, so to speak, and clothe them with a suitable and proper dress.

* * *

BILLINGS & SPENCER CO.'S EMERGENCY HOSPITAL

The Billings & Spencer Co., of Hartford, Conn., has recently added to its plant an emergency hospital for administering "first aid to the injured." Located in a corner of the machine department, it is easily accessible from all other departments of the factory, and all injuries, minor or serious, are ordered to report there for treatment.

For a number of years the company has been doing this work in a crude and rather unsatisfactory manner, using a corner of one of the lavatories for the purpose, and keeping the outfit in a wall cabinet. The results attained have been



Billings and Spencer Co.'s "First Aid to the Injured" Hospital

such that they believed better accommodations would insure even better results; hence the recent establishment of the emergency room. The room, erected for the purpose is 12 feet by 20 feet, and is finished throughout in white enamel, which can be easily cleansed... The outfit consists of an iron enameled bed; sterilizer for both instruments and dressings; cabinet for instruments, solutions and dressings; hot and cold water equipment; stretcher for transportation of serious cases from various departments; and other minor necessities.

An injury sustained by an employe is immediately reported to the foreman of his department, who orders the case to the hospital for treatment, where it is taken care of. If the injury proves too serious, the injured is either ordered home for care by his own physician or to one of the city hospitals. A custom has been established, whereby all secondary dressings are ordered to report at 9 A. M. every day for inspection and advice.

The room is under the immediate supervision of Mr. E. J. Beams, chief clerk of the factory office, whose previous experience in hospital work fits him to have charge.

* * *

According to the *Brass World*, an addition of 2 per cent of metallic sodium to lead hardens it so that it may be used for bearing surfaces. The alloy is so hard that it rings when struck.

THE EXPERIENCES OF A YOUNG TOOLMAKER*

By T. COVEY

"Mr. Anderson," said Jim, "may I eat my lunch beside you this noon, and ask you a few questions?"

"Well, Jim, I've no objection to your company," said Mr. Anderson, "and you may ask as many questions as you like, but whether I answer them or not will depend upon my ability. I would as soon talk as not, though what I say may not amount to much. If that is satisfactory, go ahead."

"I'll take chances on that," said Jim. "I've heard several of the men make remarks about multiplying errors, and I am a little curious on the subject. I should like to know how and why it is done."

"Well, it is usually done to acquire greater accuracy, and

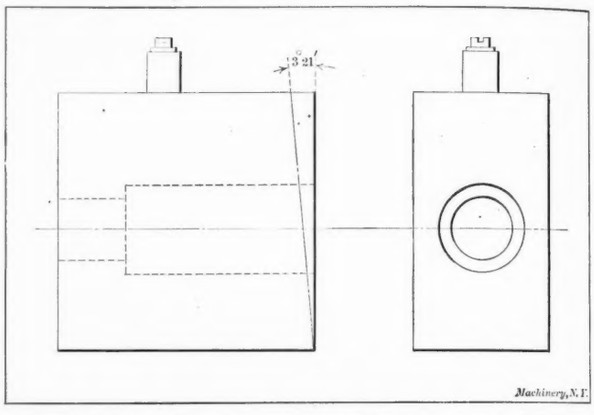


Fig. 1. Small Jig with Button Attached by which Work is set for Boring

there are innumerable ways of doing it; in fact, we have many machines and instruments for that very purpose, such as our micrometers, indicators, graduated dials, etc. However, I do not think that an explanation of them is what you want. What you have in mind is the numerous little methods and kinks obtained by practice and observation whereby we obtain greater accuracy in our work, probably the most common of which is the doubling of an error with the dividers. Suppose that I wished to lay out a radius of say 3 inches as accurate as possible, and the nearest I could be sure of getting, by setting the dividers off a scale, is within 0.0025 inch. To obtain greater accuracy than that I would scribe a straight line on a layout plate, set my dividers as near as I could to 3 inches, place one leg of the dividers on the line and with the other scribe a circle. Then taking a larger pair of dividers, or a set of trams would be better as the legs stand straighter, set one leg on the circle where it crossed the line and the point of the other where the circle crosses the line on the opposite side, using a magnifying glass to see that both points are in the proper position; then try the tram points on a scale and see what the distance between them measures. If the dividers were set right, the distance will be just 6 inches, but suppose that I am able to see that the tram points measure more than 6 inches apart, then I know that the dividers were not set right, and I proceed to readjust them; then selecting a new point on the straight line I repeat the operation. Suppose that this time I am unable to discern an error, or that the diameter of a circle scribed with the dividers is within 0.0025 of 6 inches; then, since any error that exists in the dividers would occur twice in scribing the circle, or be doubled, I know that the dividers are right within half of the least

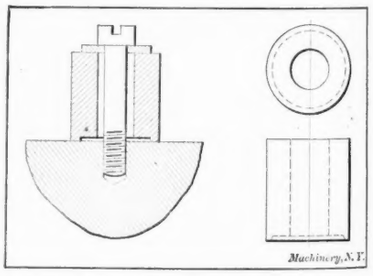


Fig. 2 Steel Bushing or Button used in Precision Work

* Previous installments of this series of articles appeared in the numbers for August and December, 1909, February and April, 1910.

error that I am able to detect, or half of 0.0025 which is 0.00125 inch. This method is practiced extensively by templet makers in laying out their work and can frequently be made use of in other ways as well.

"Here is another instance in this little jig that is lying here. (See Fig. 1.) The man that is making it has got it all squared up and a button set where he wishes to bore a hole. The next thing that he will do is to set it up on the faceplate of a lathe and chuck it true, or approximately so; then, applying an indicator to the button and revolving the lathe, note the amount that the instrument indicates that the button is out of true. This amount is just twice what the actual error is. Suppose that he is able, with the assistance of the indicator, to get the button true within ¼ of one-thousandth; he then removes the button and bores the hole; the center of the hole will not be out more than half of the amount that appeared in the periphery of the button. This can probably be best illustrated by likening it to the pin on a crankshaft which, should the distance from the center of the pin to the center of the shaft be 4 inches, would make the throw of the pin 8 inches. This would, of course, hold good down to the minutest measurements, and in the case of the button we measure the 'throw,' which is just twice the amount that the button is off center."

"I don't just understand why the button is used, Mr. Anderson," said Jim.

"Well, if you had a hole bored in that jig, for convenience say, just one inch in diameter, then if you were to put a one-inch plug in the hole and allow it to project a little it would be an easy matter to measure from the edge of the plug to the edge of the jig and add half the diameter of the plug to the measurement and thus get the distance from the edge of the jig to the center of the hole. Now suppose that instead of inserting a plug in a hole, which we can only do after the hole is bored out and its location fixed, we first lay out the hole approximately, and drill a small hole and tap it out for one of these screws that are used to fasten these buttons on with; then on fastening one of the buttons in place we have the same conditions that exist with a plug sticking out of a hole, with the exception that we can change the location of the button within certain limits, on account of the hole in the button being larger than the screw (see Fig. 2). Now assuming that we want the location of a hole very accurate, we should have the jig squared up accurately so that we can make all of our measurements from the edges of the jig; then length-rods would be made equal in length to the distance from the two edges of the jig to the center of the hole, less half the diameter of the button. Considerable care should be exercised in making these length-rods. Preferably they should be made of round cold-rolled steel, or drill rod, and they should be made like Fig. 4, with the ends faced off square between the centers of a lathe to insure their being parallel to each other. After making the length-rods and measuring them with a micrometer to make sure that they are right, one of the faces of the jig from which we wish to measure is set down on the surface-plate. The button is then adjusted until the proper length-rod can just pass between it and the faceplate. The jig is then turned onto the other surface that is to be measured from and the button is set so that the other length-rod just passes between it and the plate. These operations are repeated until the button is set so that both length-rods touch it alike from their respective sides. This is easier to do if we place a washer of paper under the button and use a fiber washer between the button and its screw head. After the button is set the jig is chucked in a lathe and the button is set to run true; it is then removed and the hole bored.

"To return to the subject of multiplying errors, let us suppose that one side of this jig had to be machined to an angle of 3 degrees 21 minutes (see dotted line in Fig. 1). This is an angle that would be difficult to secure accurately with any bevel protractor, but with the assistance of a little trigonometry and a little ingenuity, it is an easy matter. We first take a piece of paper and lay out a triangle as shown in Fig. 3. Then figure out the height of this triangle for a certain length, say 15 inches, which represents the side adjacent to the angle. The side adjacent times the tangent equals the side opposite, or in this case the height of the angle. Looking in a table of natural tangents, we find that the tangent for 3 degrees 21 minutes is 0.05854, which, multiplied by 15, equals 0.8781, which would be the height of the angle.

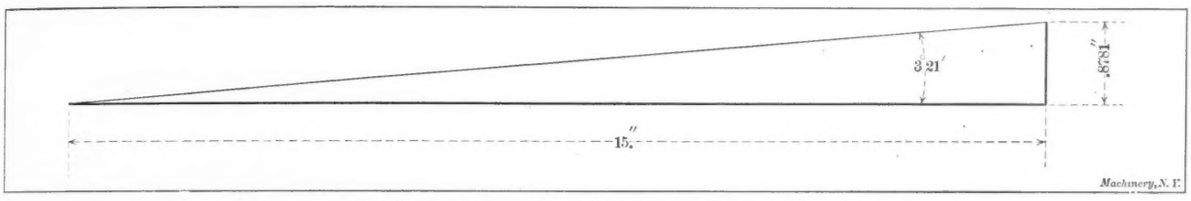


Fig. 3. Preliminary Calculation for Setting Straightedge on Machine Table as shown in Fig. 5.

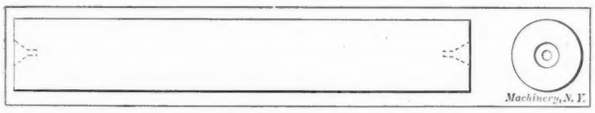


Fig. 4. Length Gages used in Toolmaking

"Suppose, for convenience, that we do this operation on a milling machine using an end mill. We will select a spot on the table where it will be convenient to clamp the jig securely and set it there temporarily, then get a straightedge about 18 inches long and clamp it at one end to the table so that the squared edge of the jig can be brought against it without changing its position materially (see Fig. 5); then measure from the edge of the table to the straightedge at the clamped end and note the measurement (as at *a*); lay off a distance of 15 inches from this point toward the opposite end of the straightedge and set the latter so that at this point it measures about 0.8781 inch more from the edge of the table than it does at the first point. (Dimension *b* would then be 0.8781 inch greater than *a*.) Now if you have an indicator, fix it securely in the spindle of the machine by means of a suitable fixture (if there is no indicator a stiff rod pointed at the end will do, by using a piece of tissue paper to get the touch with) so that the point can be brought in contact with the straightedge, and after the table is adjusted so that the end of the straightedge nearest the machine is about opposite the spindle, move the saddle in so that the indicator registers some certain amount; then set the dial on the table feed-screw to zero; next move the table toward the opposite end of the straightedge just 15 inches, counting off the proper number of revolutions, and bring the dial to zero; then set the dial on the saddle feed-screw to zero and move the saddle in just 0.8781 inch. If the straightedge is properly set, the indicator should register the same as it did at the other end; if it does not, then the position of the straightedge must be altered until it does. Thus you see the lengthwise movement of the table represents the side adjacent to the angle, and the movement of the saddle, the side opposite, or height.

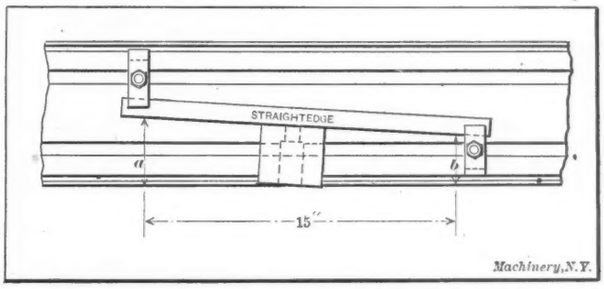


Fig. 5. Method of Accurately Setting Straightedge to a Given Angle by using Test Indicator and Graduated Feed-Screw Dials

"Now, since we have the straightedge clamped on the table at the proper angle, it is an easy matter to set the jig up

against it and clamp it there, and if a piece of tissue paper is placed between the straightedge and each corner of the jig, and if, when the jig is clamped fast, each piece of paper has about the same tension or 'feel' when pulled, we may be reasonably sure that the jig is properly set. The straightedge can then be removed and the piece machined with the assurance that the angle will be as correct as the straightedge was set. Now suppose that there was an error in setting the straightedge of, say 0.0025 inch, which is a liberal amount on a machine in reasonably good condition, and assuming that we are careful in having the backlash all out of the screws when we take the measurements, then the error existing in the angle on the jig will be in the same proportion to the error in the straightedge as the length of the straightedge is to the length of the jig bearing against it. In this case the length of the jig is three inches, then $15 \div 3 = 5$, and $0.0025 \div 5 = 0.0005$, or an error in the angle on the jig of 0.0005 inch, which is much more accurate than we could ever hope to set a bevel protractor

"As I said before, there are numerous ways of multiplying errors, and a little study of the subject will show many ways to take advantage of them; although there are instances where they act to a disadvantage. I remember once that I had a job of making a jig for drilling twenty-four ⅛-inch holes in a straight line and each a half inch apart. As a half-thousandth of an inch was tolerable for accuracy it was thought to be an easy matter, and that a short jig having three holes in it would do the work. I made up a jig of this kind which was to be used by drilling the first hole and inserting a plug, lining the jig up and drilling a second hole and inserting a plug and drilling the third, after which it was intended to move the jig along and set it by using a plug through the center hole and one in the end hole, the plugs being inserted in the last two holes drilled. On trying the jig out, however, it was found that the two end holes were about six thousandths too far apart, and that the holes were not in a straight line but on a slight curve. This was due to a slight and almost indiscernible error in the jig, but this error was repeated on each hole drilled, and therefore multiplied by the number of holes. Well, that illustrated the impracticability of the method, and the jig was thrown away and one made having thirteen holes in it, the first two and the last two a half inch apart, with the intervening holes one inch apart. In using this jig the two end holes were drilled first and plugs inserted in them; then the intervening holes were drilled, after which the plugs were removed and the jig moved along until the first hole at one end of the jig matched the second hole drilled from that end. A plug was inserted in this hole and also in the second hole from the other end of the jig; the rest of the holes were then drilled. This made a very satisfactory job, and though it was more work to make the jig, much faster drilling could be done."

"Were you blamed for making the jig wrong in the first place?" asked Jim.

"Well, no; in the first place I had made the jig according to instructions, and then it was what might be called a profitable mistake. That is, it showed the fallacy of a design that might be applied to other work of a similar character. It has been well said that we learn more from our mistakes than we do from our successes. When we make a mistake we have a precept, which is more indelibly fixed in our minds than any other training or instruction could be, that instinctively halts us when similar circumstances arise.

"A man that does not make a mistake, generally consumes so much time avoiding them that he rarely accomplishes anything else. There is a difference between mistakes and carelessness, and we should not get the two confused."

"While you were talking about machining that angle on the milling machine," said Jim, "I was reminded of an argument that I overheard between Mr. Corbin and Joe Pitts a few days ago. It seemed Joe had bored a hole in a jig on a milling machine and it did not come out right. Mr. Corbin claimed that the table of the machine was not properly set, while Joe maintained that that made no difference."

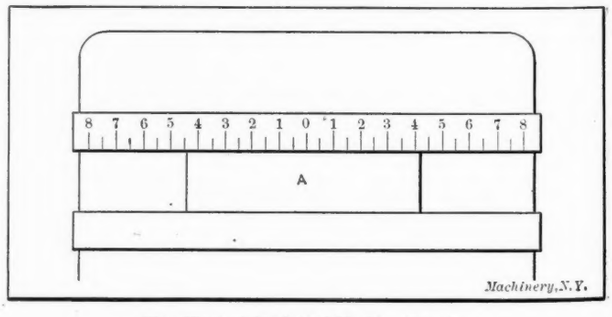
"I remember that," said Anderson. "Joe was wrong. He set his job up using an indicator along the side of the jig that was at right angles with the hole that he was to bore, with the result that while he proved that the jig was set in the proper alignment with the table, he did not prove that the table was set at right angles to the spindle, or to the saddle guides, relying on the graduations of the table base for this. Of course, when the hole was bored, it was no more accurate than the machine. You can readily see that if a piece were placed between the centers of a milling machine table, the table swiveled to one or two degrees, and a hole bored through the piece, the hole would be at an angle the same as that to which the table was set. I have frequently made use of this scheme to give draft to keyways, etc. It is evident that if one desires to bore a hole in a piece set parallel to the table guides, and have that hole at right angles to the side of the piece that was set parallel, one must be sure that the table guides are set at right angles to the saddle guides, or the spindle of the machine. This can be done by setting an indicator in the spindle of the machine so that the registering point will describe a circle of at least six or eight inches when the spindle is revolved; the indicator should then be set at one extreme of its horizontal movement and that portion of the table that has been machined parallel to the table guides brought up against the indicator until it registers some certain amount. Next revolve the spindle half over and note the amount registered; if it registers the same in both places the table is set square to the spindle, and if it does not then the table should be adjusted until it does. The machine will then be set accurate enough for all practical purposes. However, if it is desired to bore a hole of any considerable length, say five inches or more, and there is a surface on the piece that is to be bored that lies parallel to the hole other than the top and bottom, it is much more desirable to disregard the position of the table and set the work parallel to the saddle guides using an indicator along the side of the work that is parallel to the hole, thus dong away with any error in squaring the table of the machine; in fact if the table were set 10 or 15 degrees off square, it would not affect the accuracy of the work. There is a good opportunity for a man to lose sight of the fundamental principles of the thing and get confused as Joe did, but once you thoroughly understand it, it is plain to see that if work is set in line with the table guides, then to bore a hole at right angles, the table must be properly set, but if work is set in line with the saddle guides, the hole will be bored parallel to the guides regardless of whether the table is set properly or not, assuming, of course, that the piece is square and the previous work correctly done. Ah! there is the whistle, and we must get to work."

* * *

SUGGESTION FOR THE MACHINE VISE

By C. F. EMERSON

The sketch submitted herewith very clearly shows a suggestion which I have often thought would be most practical if carried out. By having the steel jaw of a shaper or planer vise graduated somewhat after the manner shown, it would



Plan View of Graduated Machine Vise Jaw

not be necessary to change the position of the stroke of the shaper ram or planer, as is so often the case after the work *A* has been placed in the vise a second time, owing to the fact that the graduations would enable the operator to place the piece in its exact former position. These graduations would also be useful on milling machine vises, as they would do away with the necessity of changing the position of the dogs of the feed-tripping mechanism.

MACHINE SHOP PRACTICE*

LAYING OUT AND MACHINING A PISTON-ROD KEY SLOT

As the laying out and machining of a slot for the keyed connection between an engine piston-rod and its crosshead, is a typical example of the kind of work the all-round machinist is often called upon to do, we shall consider this operation somewhat in detail. A very common method of attaching a piston-rod to a crosshead is shown in Fig. 1. The end of the rod is tapered and it is held in place by a cotter or key *C*, which is inserted in a slot passing through the crosshead and rod. As this key is driven in, the taper side, which bears against the inner end of the rod slot, tends to wedge or draw the rod tightly into place. In order that the key will have this drawing action, the slot in the rod must be off-set as shown, and as keys are usually made to a standard size, evidently this slot must be laid out and machined so that the tapering side of the key, when driven tightly in place, will bear evenly across the slot. It is also desirable that the key

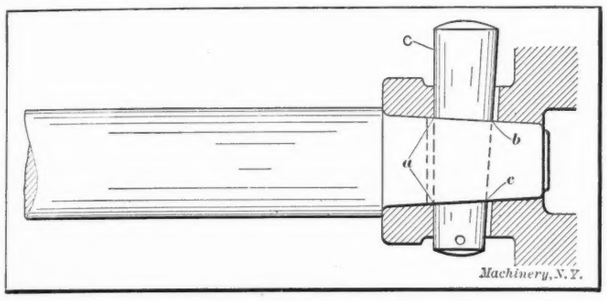


Fig 1. View showing Method of Securing a Piston-rod to its Crosshead by a Key or Cotter

be tight soon after the small end has passed through the crosshead as in Fig. 1.

It will be seen that the most important thing in connection with the laying-out operation, is to locate points corresponding to *b* and *c* on the rod, as this is the side of the slot against which the key bears. To quickly and accurately locate these points, first insert the key in the crosshead, as in Fig. 2, in the position which it will occupy when it is driven through the slotted rod; then with a hook scriber, draw lines *l* and l_1 across one side of the key to coincide with the inner sides of the crosshead bore. After the key is removed, the rod should be driven in and the outline of the crosshead slot on each side transferred to it by using a sharp pointed scriber. The rod before being removed should be marked in some way so that the scribed line, representing, say, the outer half of the crosshead slot, can be identified. (By outer half is meant the side from which the key is driven.) To locate a line representing the point *b* (Fig. 1) on the rod, the latter is clamped in a vise with the marked or outer side up. The exact width of the key at *l* (Fig. 2) is then measured and a pair of dividers is used in transferring this measurement to the rod, as illustrated in Fig. 3. The line corresponding to point *c* (Fig. 1) is also scribed on the opposite side of the rod with the dividers set to the width of the key at l_1. Circles are now laid out on each side of the rod, as shown by the heavy lines, for drilling. The last circle on the end next to the shoulder should extend 1/8 or 3/16 inch beyond the end line *a* so that the slot will clear the key on this side. The diameter of these circles is, of course, equal to the width of the key, as many are laid out as will come within the length of the slot so that as much metal as possible will be removed by drilling.

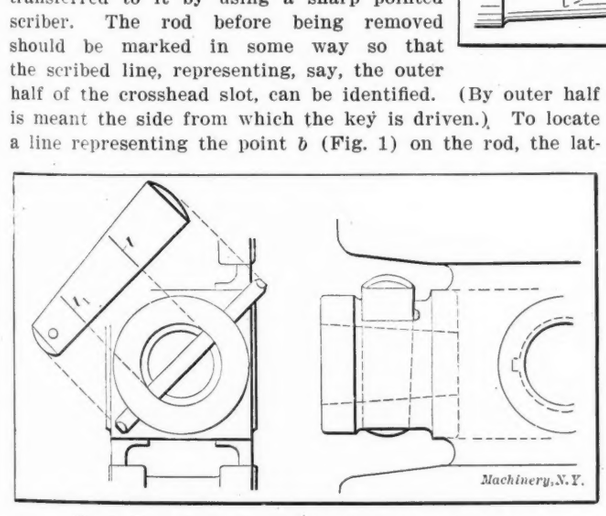


Fig 2. Using Key in Connection with Laying-out Operation

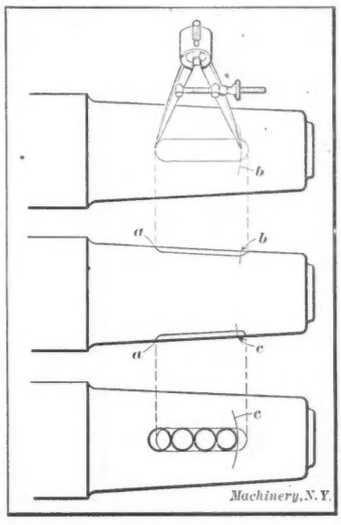
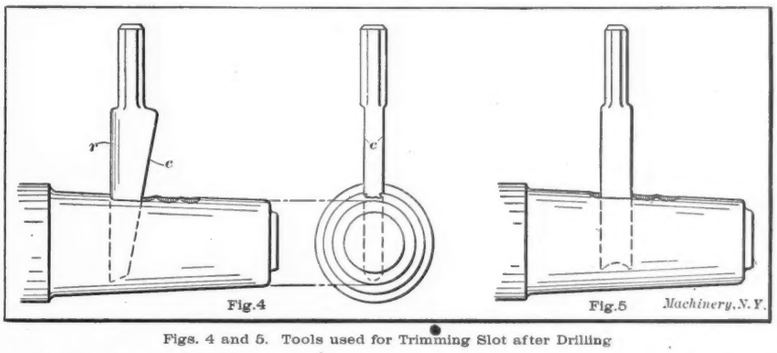


Fig. 3. Laying out the Slot

After all the holes have been drilled half way through from each side, as described in the Shop Operation Sheet accompanying this number, the slot is finished by chipping or broaching, and filing. The ridges on the sides may be removed by the use of an ordinary side chisel, but where slots are frequently cut, the work can be done more quickly by the use of a special chisel such as is shown in Fig. 4, or by a broaching chisel as illustrated in Fig. 5. The first tool is shaped somewhat like a gouge. The side *r* is rounded to fit easily in the drilled holes, and the cutting is done by the corners *c*, which are given a little clearance on the sides. As the tool is driven down through the slot, the tapering cutting edges advance and shear off the ridges on both sides, which have been left between the holes. The width of this tool is slightly less than the required width of the slot so that practically all superfluous metal is removed, and little filing needs to be done. The broaching chisel shown in Fig. 5 can also be employed for this work. The end is ground concave so that it will cut with a shearing action and the tool is given a slight amount of clearance on all sides. The manner of using these tools should be apparent from an inspection of the illustration.



Figs. 4 and 5. Tools used for Trimming Slot after Drilling

After the chipping or broaching operation is completed, the slot should be finished by filing, a flat file being used for the sides, and a round or "rat-tail" file for the ends. The taper end against which the key is to bear, should be finished to coincide with the lines *b* and *c*, Fig. 3. The accuracy of the work may be tested by inserting the rod into the crosshead (after all the burrs around the slot edges have been removed) and then driving the key in tightly. If, when the latter is removed, there is not a good bearing across the end of the slot, the "high spots" should be filed down until the bearing is uniform.

To prevent a key from dropping out of its slot in case it becomes loose, a small split cotter is inserted in the end. In order to have this cotter close up to the crosshead where it will be the most effective, the hole for it should be laid out after the slot is finished and the key is driven to its final position.

* With Shop Operation Sheet Supplement.

HEAT TREATMENT OF CARBON STEEL

By J. H. GILL*

High-speed steel is in fashion nowadays. This fact together with the high degree of skill required to get the best results from carbon has caused carbon steel to be neglected. For some kinds of work, however, carbon steel is superior to any high-speed steel on the market, if it is dressed properly and receives the proper heat treatment.

The carbon in steel may be in one of two forms: Annealed steel has the carbon in the non-hardening or cementite form. Hardened steel has the carbon in the hardening or martensite form. That these are two distinct forms may be seen by taking a small piece of annealed steel and a small piece of hardened steel and dissolving each in hydrochloric acid. The annealed steel will dissolve, leaving a black residue, while the hardened piece dissolves, leaving no residue. This shows that in one case some of the carbon is in the free or graphitic form and does not dissolve in acid while in the other case, the carbon is in the combined form and all dissolves.

Sample of Carbon Steel broken to show Difference in Grain at Different Hardening Heats

Another point that is more important to the steel worker is that the carbon changes form suddenly at the critical temperature. This is shown in the sample reproduced in the accompanying half-tone. This sample was made in the following way: A piece of steel ½ inch x 1 inch was heated and nicked parallel with the axis as seen in the engraving; then this piece was heated till it began to fuse on the end *A* the heat gradually decreasing toward *B*. The end *B* was not hot enough to harden. In this condition the piece was cooled as quickly as possible and then broken along the nick. The characteristic burned grain is seen at *A*. This gets finer as the part that is not so badly burned is reached. Just before the point *C* is reached we find the maximum fineness and the maximum hardness; as soon as the line *C* is crossed, we find the grain of the annealed steel. The sample is soft from *B* to *C*. This shows that there is a sudden change, on the rising heat, at *C*. The best condition for hardening is just after crossing this line.

The determining of the point *C* is a very important matter. The temperature at which this change takes place varies with the different steels. There are several ways of determining this point. One is by heating the steel to a dark red, plunging it into the hardening bath and trying with a file. If not hard, reheat to a little higher temperature and try in the same way. In this way go up step by step till a point is reached at which the steel hardens. This reheating and hardening is a severe treatment and is likely to cause cracks, but if carefully done it will give the lowest heat at which the steel will harden.

There are two other methods which depend on the fact that steel loses its magnetic properties when the hardening point is reached. A piece of steel heated to a dull red and brought into the plane of a magnetic needle will attract the needle. [See MACHINERY, April, 1908.] If heated until the temperature is above the hardening point, there will be no attraction and the needle will not be affected by the presence of the steel. In using this test, care must be taken that the presence of the tongs does not mislead the workman. The comparatively cool tongs may attract the needle even when the steel is above the critical point. An ordinary horse-shoe magnet may be used instead of the magnetic needle. It is less likely to mislead because of the tongs or cooler parts of the steel but is less sensitive. A bar magnet hung on a pivot at the center and provided with a handle can be used very satisfactorily. It can be introduced into the furnace to test the steel during the process of heating and is more convenient than either of the other methods. It is not necessary to test every piece of steel, but a test should be made whenever the person takes another grade of steel or whenever the light changes. The intensity of the light makes a great difference in the color of a piece of iron or steel at a given temperature.

If steel workers would observe the following in all cases when hardening steel, they would have better results: *Harden carbon steel at the lowest possible heat and always on the rising heat.* The last part of this rule is the one more often overlooked. Steel may be forged at a higher heat than the hardening heat but should in all cases be annealed before being heated for hardening. The grain of the steel corresponds to the highest heat it has received since it was black. If a piece of steel is forged at 1600 degrees F. and allowed to cool down to 1400 degrees F. to harden, it will have a grain corresponding to 1600 degrees. If the piece is forged at 1600 degrees F. then cooled down to the black heat and reheated to 1400 degrees F. and hardened, it will have a grain very much finer and the tool will be very much better.

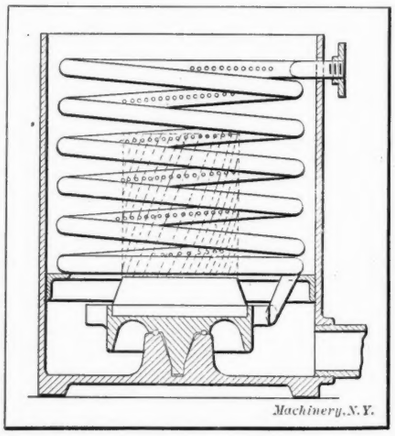
In making tools that are machined to shape it is always best to rough out the tool, and then anneal it to relieve all internal strains. After annealing, finish to size and it will be much more likely to come from the hardening bath straight and free from cracks. If, in heating for hardening, any part of the tool gets too hot, lay it one side and let it cool slowly to the black heat and then reheat more carefully.

In working steel always have even, thorough heat, all the way through. More steel is injured by uneven heat than by too high a heat.

* * *

APPARATUS FOR HARDENING MILLING CUTTERS

The accompanying illustration from the *Practical Engineer* (London) shows an apparatus for hardening milling cutters, patented by Mr. J. M. Gledhill of Armstrong, Whitworth & Co., Ltd., Manchester, England. As is well known the best results in hardening milling cutters are obtained when only the teeth are hardened and the interior of the cutter left comparatively soft. Instead of plunging the cutter directly into water or other cooling liquid, the exterior of the cutter only is subjected to the action of the cooling liquid in the form of a spray through a series of fine jets at high pressure. The interior is kept soft by previously plugging the hole to protect it from the sudden chilling action. The cutter is made to revolve during the hardening or sprinkling process in order to expose thoroughly every part of the teeth to the spray. The chilling action may be stopped at any desired point by turning off the water, and the cutter is then gradually cooled by immersion in oil or other suitable cooling medium. This method also almost entirely eliminates the cracking of cutters in hardening. The illustration clearly indicates the construction of the apparatus with a coiled pipe surrounding the cutter which is shown in dotted lines. The cutter rests on a carrier mounted on a ball bearing. The carrier is provided with vanes so that it may be caused to revolve by the action of a jet of water from the end of the coil. The water is drained off through an outlet at the bottom of the tank.



Hardening Milling Cutter Teeth by a Spray of Cooling Liquid, leaving the Central Portion Comparatively Soft

* * *

The best mixture for bronze letters used for signs is, according to the *Brass World*, 88 per cent, by weight, of copper, 8 per cent of tin, 2 per cent of lead, and 2 per cent of zinc.

* Address: University of Illinois, Urbana, Ill.

AREAMETER FOR MEASURING HIDES

By FRANK C. PERKINS*

The general construction and method of operation of a novel form of areameter may be seen in the accompanying engravings, Figs. 1 and 2. This instrument is of great value for the accurate measurements of patterns and hides, as well as other areas having irregular outlines. In Fig. 1 the areameter is shown suspended over a table large enough to accommodate a hide of the size usually handled, and as the

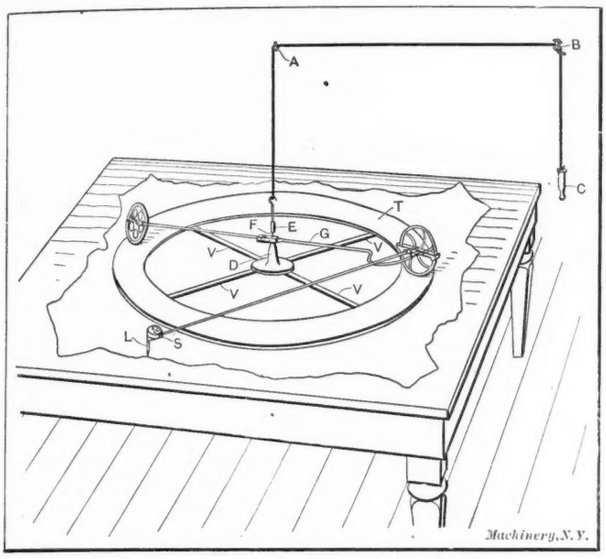


Fig. 1. Areameter used for Measuring Hides

measurement is obtained by tracing the outer edges of the hide, a table accessible on all sides is preferable.

The ordinary pulley *A* is screwed into the ceiling above the center of the table, and the self-locking pulley *B* is placed to one side of pulley *A*, approximately over the edge of the table, where the operator can reach the weight *C* conveniently.

A large wooden disk *T* with center weight *D* and cross-braces *V* is placed on the table, and a center pin screwed firmly into the center weight. The areameter is placed on the disk, being held in position by the center pin *F*, which is inserted through the hole at the middle of the jointed arm. The balanced wheels are fastened to the ends of the arm *G* as shown in Fig. 1. The swivel *E* is then securely fastened to the center pin and the cord which is attached to the lifting weight is passed over the two pulleys. The areameter is then ready to be used.

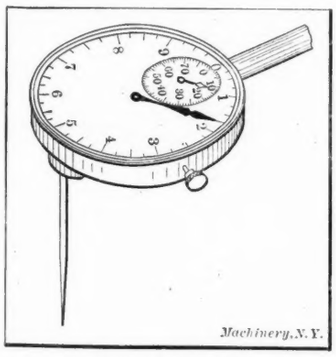


Fig. 2. Pointer and Dial of Areameter

In measuring hides, the areameter is placed on the leather in such a position that every portion can be reached by the pointer *L*. Small pieces of leather and patterns must be placed outside the wooden disk, unless, of course, they are larger than the disk, in which case the latter should be placed on them in the same manner as on a hide. The pointer is then placed at some designated mark on the outer edge of the hide, both hands on the dial *S* pointing to zero. By lifting the pointer slightly and guiding it with the aid of the thumb or forefinger along the outer edge of the leather, it is made to follow the outline of the hide back to the starting mark. The dial will then show the total of the area measured. The large circle of figures shows the number of square feet from zero to ten, and the small circle of figures shows every five feet, as shown in the engraving of the indicator in Fig. 2.

The operator traces the outer edge of the hide to the right. In case of holes, the complete hide should be measured first, and the pointer then passed around the holes to the *left;* then the exact area with the holes deducted will be indicated directly on the dial. The speed at which leather can be measured varies with the size of the hide, a 50- to 60-foot hide being measured in less than a half minute's time.

* Address: Erie Co. Bank Building, Buffalo, N. Y.

* * *

FORMULAS FOR THE VOLUME OF A PART OF A SPHERICAL SEGMENT

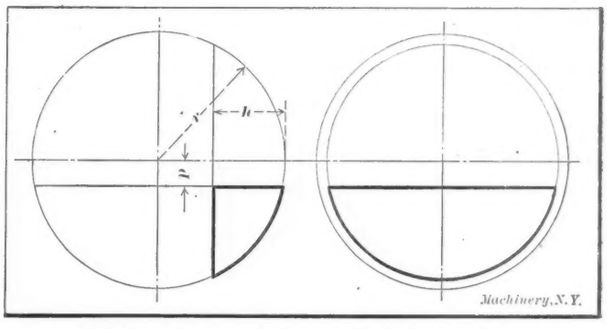
In the March, 1910, issue of MACHINERY a formula by Mr. R. A. Jewett, for finding the volume of a part of a spherical segment, was published. Mr. John B. Sperry, of 583 Benton St., Aurora, Ill., offered a different solution and formula previous to that submitted by Mr. Jewett, but, owing to an oversight, this formula was not published at the time it was submitted, and is, therefore, given below.

If V equals the volume of a part of a spherical segment, and h, p, and r equal the dimensions indicated in the accompanying engraving, then:

$$V=0.5236\left(3rh^2-h^3-3pr^2+6pr^2\frac{\sin^{-1}\frac{r-h}{r}}{180}\right)+p(r-h)\sqrt{2rh-h^2}$$

This formula is derived by calculus, and owing to the length of the derivation, it is not possible to reproduce it in MACHINERY.

A simplified form of the formula by Mr. Jewett is offered by Mr. W. L. Tryon, 8 Hamburg Ave., Schenectady, N. Y. The symbols in this formula are the same as those used in the



Notation used in Formula for Part of a Spherical Segment

Jewett formula published in the March, 1910, issue, and the simplified formula is as follows:

$$V=\frac{2SP\sqrt{r^2-S^2-P^2}}{3}-\frac{3r^2P-P^3}{3}\tan^{-1}\frac{\sqrt{r^2-S^2-P^2}}{S}-\frac{3r^2S-S^3}{3}\tan^{-1}\frac{\sqrt{r^2-S^2-P^2}}{P}+\frac{2r^3}{3}\tan^{-1}\frac{r\sqrt{r^2-S^2-P^2}}{PS}$$

It will be seen that in the formula above there is but one radical ($\sqrt{r^2-S^2-P^2}$) the square root of which must be extracted, and this makes the formula very much simpler than that in the March issue from which it was derived. The derivation is too lengthy for publication.

* * *

It is stated in the *Iron Age* that, according to computations by the British Commercial Commissioner to Canada, the capital employed by American manufacturers in Canadian branch works amounts to about $125,000,000. The number of firms having branches in Canada amounts to nearly 150. The tendency of American capitalists to manufacture in Canada is, of course, largely caused by the Canadian tariff, which, in turn, is largely due to our own tariff against Canadian products. Here is then a case where the tariff indirectly has caused an exodus of capital from, and a diminished demand for labor in, the United States.

* * *

The English Admiralty specification for phosphor-bronze of great strength is, according to the *Brass World*, as follows: copper, 90 per cent; tin, 9.7 per cent, and phosphorus, 0.3 per cent.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

A POINT IN ROUGH TURNING

In manufacturing the ordinary sizes of machine tools there are many places that have to be machined, belonging to the class indicated in Fig. 1, which have to be reduced an inch or more in diameter and a few inches in length. The particular piece illustrated, which will be taken as an example of this class of work, is a rough-turned pinion for a lathe apron. The stock comes to the lathe cut off and centered, to be rough turned from 2⅛ inches in diameter to 15/16 inch diameter—a reduction of 1 3/16. As this is merely a question of rapidly removing the stock, no attention need be paid to the smoothness of the cut. Now if one single tool should be used, either

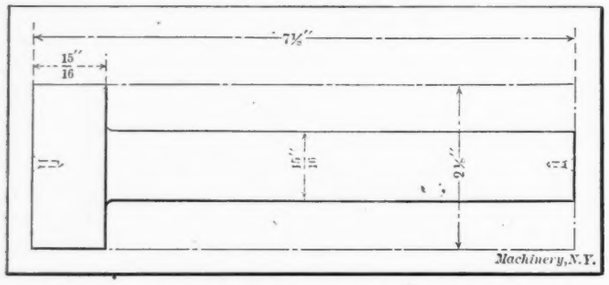


Fig. 1. Class of Work on which Two Tools can be advantageously used for Roughing

two separate roughing cuts would have to be taken, or a fine feed used, because of the cutting pressure on the work. Neither the tool nor the machine, however, would be loaded anywhere near its full capacity, as the size of the cut is limited in this case by the strength of the work, and not by the capacity of the machine or tool.

The tool pressure produces, as the cut starts, a large compression of the metal surrounding the rear center, and, if the center is small, it is liable to break out or destroy the tailstock center. Furthermore, the tool pressure causes the work to spring, and when the turned diameter is only 15/16 inch, this bending is very likely to cause trouble. In order to counteract these drawbacks and to insure the possibility of loading the machine to the full capacity, lathes are equipped with two tool-posts and two turning tools, one being used in the front

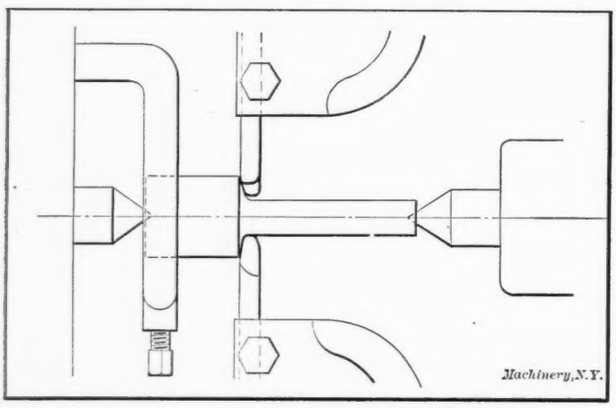


Fig. 2. Arrangement of Tools for Taking Heavy Cuts on Small Work

and one in the rear in an inverted position. The arrangement is illustrated in Fig. 2.

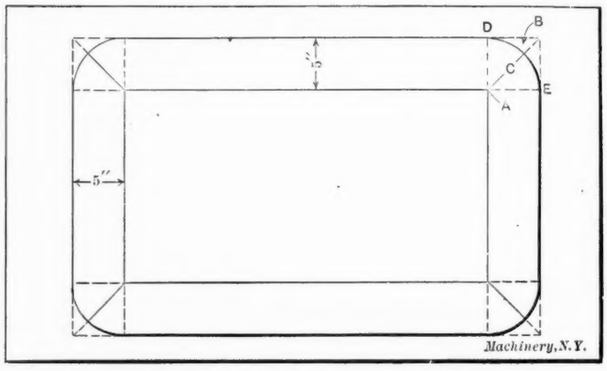
Considering the pressure on the work, the tool pressure on one side is downward and on the other upward, these tending to balance each other as far as bending is concerned. The rear center and the turned part of the work are thus relieved from nearly all the strain. There is a slight strain, however, as the front tool is usually set to take a slightly deeper cut than the back one. By this method the time of rough turning the class of work referred to in the foregoing, can be reduced to less than one-half, because each of the two tools can be made to remove more stock than would a single tool.

Cleveland, Ohio. OSKAR KYLIN

[The principle of two opposed tools to balance heavy lathe cuts is well known and much used in certain classes of manufacture, of course, but it is doubtless not used as generally as it could be with profit.—EDITOR.]

TINNING STEEL PANS

Before steel pans can be tinned all scale must be removed; this can be done in a pickling solution, composed of equal parts of hydrochloric acid (or muriatic acid, as it is often called) and water. Lead tanks are sometimes used for holding the acid, but it is better to obtain an enameled fire-clay bath (such as used for lavatory sinks) or any earthenware vessel that is large enough to cover a quantity of the steel pans at the same time. During the time the pans are in the pickle they should be moved about, so that all parts may be equally exposed to the action of the acid. The length of time for pickling will depend upon the temperature and strength of the acid and on the condition of the pan surfaces. If the acid is fresh, then the pickling may be done in about ten minutes, but if the acid is partly spent thirty or forty-five minutes will be required. The acid must not be heated to increase the speed of working, as the pan surface produced will not be so good as when pickled by cool acid. Any increase of temperature over and above that of the atmosphere required for the effective working of the pickle, is soon obtained by the



Method of Making Tank for Steel Tinning

heat generated through the chemical action. If the pickling solution is too hot, the action upon the pans will not be uniform, and the surfaces will be somewhat rough. To obtain a good-looking surface after tinning, the operator should be careful not to over pickle, as this will cause the pans to look "dead" and "dry." When properly cleaned, the pans should instantly be plunged into a water tank for washing; they are then ready for the flux.

The tank used for tinning can easily be made from 1/16-inch sheet steel. To form the sides, lay out a line 5 inches in from the edge all around, as shown in the accompanying engraving, and then with the intersecting points *A* as centers, scribe arcs for rounding the corners; the portion *B* is then cut away. In working up the corners care should be taken to get them true; the way this is done is as follows: Press the corners over the tip of a sharp stake and bend on the line *C;* this will start the corners and slightly turn up the sides, which can then be bent on a sharp stake assisted by a large wood mallet. When the sides are bent up sufficiently, the corners should be knocked together to make the points *D* and *E* meet, and then bent around on the ends of the pan against which they should be closely flattened. This completes the tank.

When preparing the bath of molten tin, sufficient metal should be obtained to cover the steel pans. The tin can readily be melted over an ordinary forge fire, but care must be taken not to overheat it; the temperature should be about 400 or 450 degrees F.

The flux into which the pans are dipped previous to tinning them is composed of a solution of chloride of zinc, that is

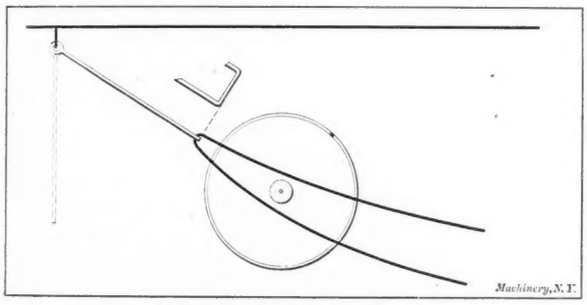
made by dissolving zinc in hydrochloric acid to the saturation point. The steel pans should be heated slightly before putting them into the molten metal. Care should also be taken when immersing the pans to place them in gently, as the molten tin coming in contact with the damp surface of the work boils and "spits." The pan should be moved briskly in the molten metal by means of a pair of smith's tongs, and then removed quickly and shaken over the bath. When the tin has drained to the lower edge, it should be wiped off with a pad of tow or wadding. If the coating of tin is not satisfactory after the first attempt, the work should again be dipped in a solution of zinc chloride and then in the tin, as previously described. A second dip generally improves the appearance of the surface. The work should finally be washed with plenty of water and then dried with clean sawdust. This completes the tinning operation and if the proper method has been followed and care exercised, the pan should have a smooth coating, uniform in depth and color.

FOREMAN TINNER

BELT KINKS

In a small shop where I worked they take very good care of their belts, and here are some points as to how they do it.

Near each pulley on the line-shaft where a belt drives a machine that is liable to stand idle for some time, a staple is driven into the ceiling and a hook of 5/16 or 3/8 inch round iron is hung from the staple. The hook is long enough to reach almost to the rim of the pulley but a little to one side of it. When a belt is run off its pulley, it is hooked up by the belt stick on this hook, the slack of the belt allowing it to be caught on the hook, and when the belt sags, the hook swings so as to make the belt clear the side of the



Method of Suspending an Idle Belt

pulley and also the shaft, as shown in the illustration. This avoids the trouble of tieing belts to beams, hangers, etc; and it is so little trouble to hook the belt up, that it is done when it might not be tied up. Care must be used, of course, in placing each hook, so that the belt, when off the pulley, will reach the hook.

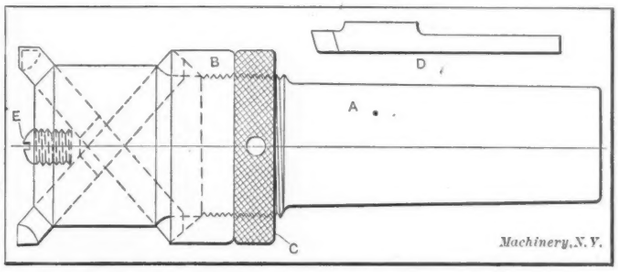
Here is another important point in the treatment of belts: At inventory time or other "shut-down," the belts are examined and the greasy or dirty ones are first scraped to remove the surface dirt, and are then washed with warm soap and water, care being taken that the water is not hot enough to be uncomfortable to the hands. After drying, they are given a light, even coating of castor oil on the working side, and if very dry, on both sides. In fact, those belts running in hot or dusty places are oiled rather frequently. This improves the driving power greatly and can be done without taking the belts down, but simply running them off their pulleys.

For belt joints, they have given up all hooks and lacings for permanent joints. When a new belt is put on, it is laced as tight as it will run, and after the stretch is pretty well out, the ends are beveled, the belt is drawn up with clamps, and a lap-joint is made, the slack due to the stretch of the new belt furnishing all the lap that is needed. This is usually not over three inches and frequently not more than one and a half or two inches for short belts, but long experience shows that it is enough. This treatment has been applied to high-speed and low-speed belts of the widths usual for the average machines and tools—or say up to four inches—and for several years it has been a success. It also enables all the short pieces of belting to be used without the usual trouble due to several laced joints in one belt, and it is surprising to see how much good belting will be found in a lot of old belts that have been well cleaned and oiled.

TAD

EXPANDING BORING TOOL

An expanding boring tool, intended for use in a turret lathe, is shown in the accompanying illustration. This tool can also be employed in a common lathe or drill press, but it is especially adapted for boring cored holes, brass bushings, etc. The shank *A*, which is made from mild steel, is turned to fit the turret and is threaded 14 threads per inch for the knurled nut *C*. The collar *B* is a sliding fit over the threads and is casehardened. The holes for the cutters are $\frac{3}{8}$



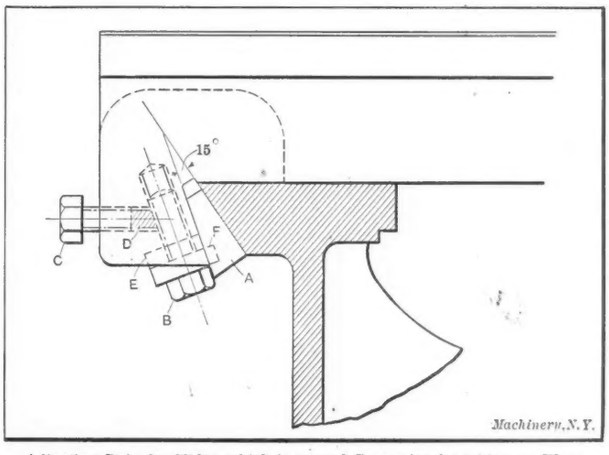
Expanding Boring Tool for Cored Holes, Brass Bushings, etc.

inch in diameter and cross each other. The cutters are made from $\frac{3}{8}$-inch round steel and are cut down for part of their length to the center line as shown at *D* so that they will cross each other when in position. After the cutters are made and hardened, they are put in place and adjusted to a trifle over the desired size, and locked with screw *E*. They are then ground to size in a grinding machine and backed off.

Harrison, N. J. A. L. MORE

IMPROVED ADJUSTING STRIP FOR SLIDES

It seems to be a universally accepted fact that the taper strip for taking up the wear in the slides of machines is a big improvement over the older types in which all the pressure was taken by the adjusting screws. The metal-to-metal contact of the former is practically equal to a solid slide; but at the same time it is rather an awkward job to plane, as the taper necessitates an extra setting of the slide; in addition to which the planing and fitting of the strip are much more difficult than with the older designs. To overcome this constructional difficulty, I designed the adjusting strip shown in the



Adjusting Strip for Slides which is moved Crosswise for taking up Wear

accompanying sketch, and I think it will be admitted that where it can be used, and especially where the pressure tending to lift the slide is small compared with the side pressure, it is just as effective as the other kind and much easier to machine and fit.

The illustration shows the application of this strip to a lathe saddle, it being at the rear for convenience of adjustment. The strip *A* instead of tapering lengthwise, tapers 15 degrees in cross section. It is adjusted by screw *B* (of which there are two or more) which has a collar sunk into the strip

at *F*; *E* is a counterbored hole to receive the collar of the screw when the latter is screwed up.

At *D* there is a brass block which is tapped in position to fit the threads of screw *B*; *C* is a lock-screw which clamps the brass block onto screw *B*, thus effectively locking it.

Of course there are, no doubt, many places where the usual end adjustment is the only one that is possible, but the strip described in the foregoing, where it can be used, has a few advantages from a manufacturing point of view. RACQUET

DIE-MAKERS' CLAMP

There are many forms of die-makers' clamps in use, and many have been described and illustrated in the mechanical publications, but the one illustrated herewith has the good points of several combined in one. First, the range of adjustment in the ordinary clamp is too limited, especially where there are punches with round shanks to mark off, as they add at least two inches to the height; and those with three arms are only useful for round jobs. This clamp is adjustable for

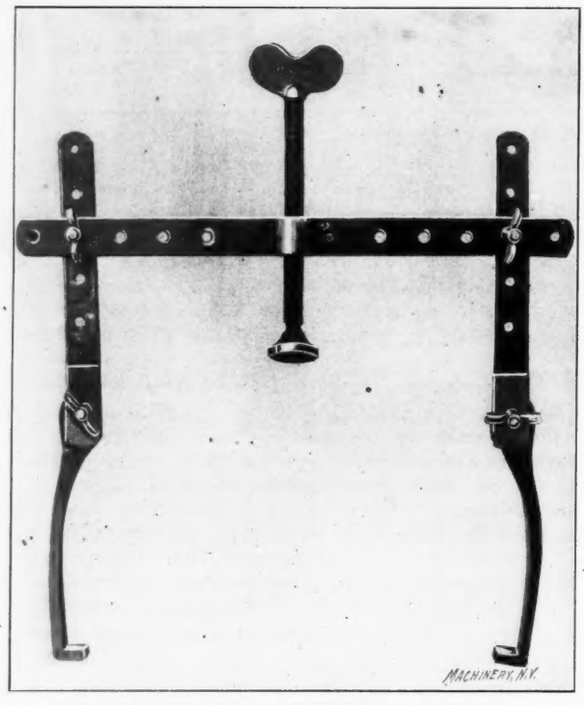


Fig. 1. Die-makers' Clamp with Wide Range of Adjustment

width and height, by spaces of one inch. It will take in, extreme adjustment, 11 by 11 inches, and it can be contracted to 1 inch in width and to zero in height. The adjustment is quickly changed by four ¼-inch thumb-screws. The clamp-screw, which is ½ inch diameter, has a 5-inch length of thread, with a ball tip and button shoe, that adjusts itself to any angle. Fig. 2 shows the arms or tongs uncoupled from the extension arms and coupled direct to the cross beam, thus giving the clamp a quick adjustment for small work.

The clamp can be easily made as it is built up of riveted strips of standard stock, the only forged parts being the tongs.

N. S. Pittsburg, Pa. WILLIAM A. PAINTER

SUGGESTION BOX IN THE FACTORY

A system for rewarding meritorious suggestions on economical methods in the shop was first introduced in our factory about two years ago, the plan being similar to that adopted by the National Cash Register Co. of Dayton, Ohio.

The adoption of this idea in our shop can be traced directly to an incident in which I was directly concerned, and which had to do with a dispute that arose as to whether I or the

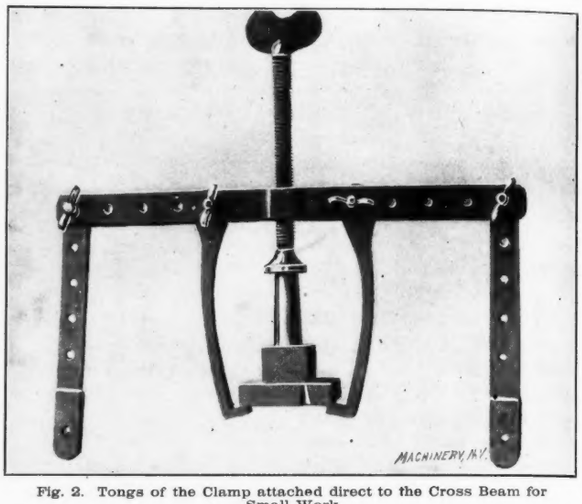


Fig. 2. Tongs of the Clamp attached direct to the Cross Beam for Small Work

superintendent of the factory was the original discoverer of a means whereby, with the adoption of follow dies, the separate operations on a blank could be reduced from three to two, with a consequent saving in time and cost of tools.

While endeavoring to improve the manufacturing methods on a certain part of the typewriter which we manufacture, I called the superintendent to my board to consider the advisability of making certain changes in the construction of the press tools used on this piece, with the idea of reducing the number of operations necessary to finish it. He, after having carefully gone over my suggestion, pronounced it impractical, and let the matter drop. A few days after he came to me, and reminding me of the job on which I had been working, proceeded calmly to unfold to me as a good idea of his own conception the very suggestion which I had made to him a few days previous. As the general manager of the company was present at the time, and as the superintendent was taking the credit to himself for my idea, I produced my sketch book, showing in black and white that he was either mistaken in his claims or had deliberately stolen my thunder.

So impressed was the general manager with this incident that a system of reward for suggestions on improvements in the shop and office systems, followed in a few weeks time. The plan provides that all suggestions shall be written out fully and clearly, accompanied by necessary sketches, and be considered by a committee from the factory composed of the foremen of the most important departments, together with the superintendent. If the suggestion offered is adopted, a nominal reward of two dollars is paid the man who offered it, and his name is included in a list made up at the end of every month, containing the names of those who have had their suggestions adopted.

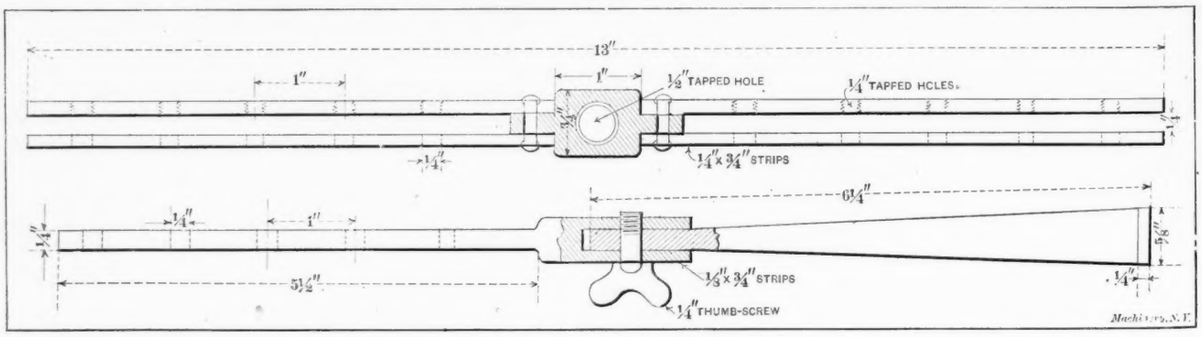


Fig. 3. Details of Die-makers' Clamp

This plan has been of undoubted value in securing suggestions from some who would otherwise be reticent about offering their ideas for the good of the service, owing to the fact that the foreman is so often given the credit, or because the plan is often rejected without proper consideration if coming from some one not in authority, as it is thought unworthy of serious thought and attention. Nothing is so galling to a man in the shop, perhaps, as to see someone else praised for something which was his own idea.

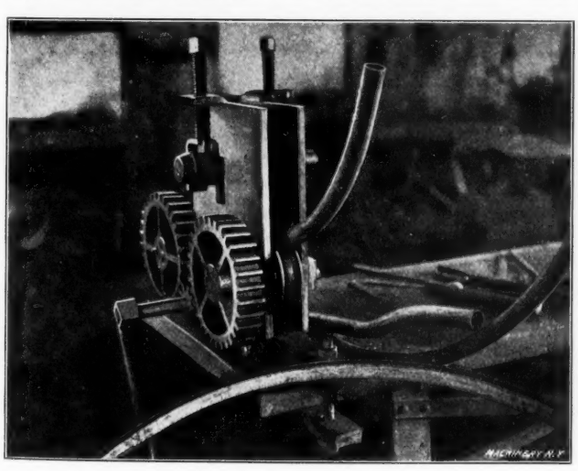
The main benefit to the man rewarded, is not so much in the two dollars which is given him to cover the time spent in preparing his suggestion, which work must usually be done at home or at the noon hour, as in the knowledge that his efforts are appreciated, and that his name is before those in authority. He also realizes that the next time promotions are made he stands a better chance of consideration through what he has accomplished.

The management of our company is highly pleased with the results accomplished after having this system in operation for a year and a half. The money spent in this way is many times repaid by the economies made possible, and besides that consideration, the men in the shop are imbued with a more loyal and liberal spirit toward those in authority.

DESIGNER

MACHINE FOR BENDING PIPE AND ANGLE IRON

A machine which is adapted for bending either pipe or angle iron, is illustrated herewith. The machine as shown in the illustration, is set up for bending pipes. It has three concave rolls (when used for bending pipe) which are located so that the centers of the rolls form a triangle. The pipe is given the desired curvature by screwing down the upper central roller by the two screws shown. The particular pipes bent in this machine are 3/32 inch thick, and this tubing after being bent is about 1/32 inch out of round. When the machine is used for bending angle iron, the concave rolls are replaced by three rolls which are grooved to receive one leg of the angle; in addition there are four side-bearing rolls which are to prevent the angle iron from bending to one side. This machine is cheaply constructed, but very substantial. The side-plates or frame are made from 7/8-inch boiler plate. The shafting is of cold-rolled steel. The pipe rolls are of cast iron, while those for bending the angle iron are of steel. Elongated holes through which the shaft of the upper roller passes, permit the necessary



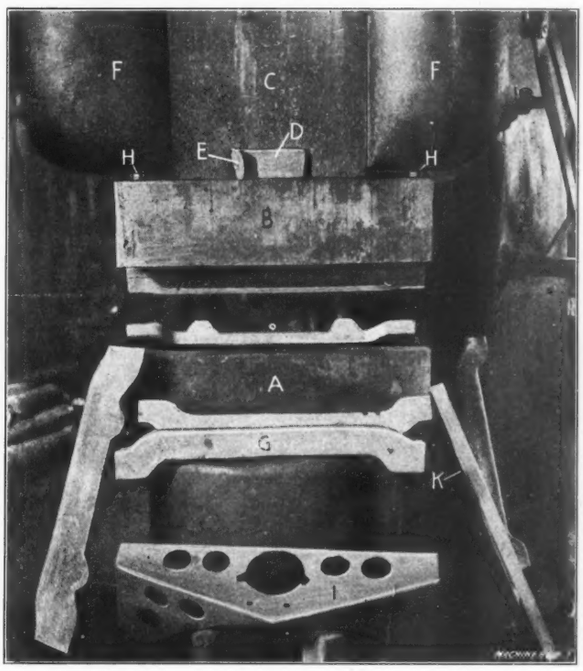
Machine for Bending Pipe and Angle Iron

vertical adjustment. This machine rolled fifty-six angle irons to a circular shape 71¾ inches in diameter in four hours, the work being done by three laborers. None of these angle iron hoops which were subsequently used in connection with a well-casing, were out of round more than one-half inch.

Jackson, Tenn. T. O. MARTIN

MAKING PRESSED STEEL PARTS UNDER THE STEAM-HAMMER

A steam-hammer that is equipped with dies and used as a press for forming pressed steel parts, is illustrated herewith. This hammer does the work very accurately, and much more rapidly than is possible with the hydraulic press. There are three sets of dies used for forming the three differently-shaped cross-members, *G*, *I*, and *K* for automobile frames. Either of these sets of dies, which are made from a good quality of cast iron, may be quickly attached to the hammer. The dies used for pressing the parts *G* and *K*, were cast in chills, it being an easy matter to forge the chills so that very little was left to machine. The dies for pressing the member *I*, were cast from a pattern, and have given excellent service. Each set of dies is equipped with positive knock-outs for removing the pressed part on the upward stroke of the ram. These knock-outs, which are indicated at *H*, consist of round-headed bolts which are set into counterbored holes in the upper die *B*. Beneath the head of each knock-out pin, and



Steam-hammer equipped with Dies for Forming Steel Parts

in the counterbored part of the hole, there are small springs which support the knock-out pins. When the die *B* approaches the end of its upward stroke, the knock-outs are forced down by the frame *F*, thus removing the pressed part. The two knock-out pins are then returned to their original position by the spring as the ram descends.

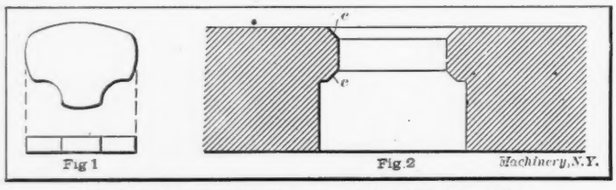
The dovetailed piece *D* by which the die *B* is keyed to the ram, is detachable, being attached to the die by means of cap-screws which fit in counterbored holes and pass through the dovetailed piece into the die. This same dovetail is used on all the dies; this is done in order to lessen the cost and complication in the die making. When a new set of dies is to be attached to the hammer, the holes in the piece *D* are transferred to the punch as follows: After putting the bottom die in place and keying it securely in the anvil block, the upper die or punch is placed in position. Two center punches which have been machined to fit the holes in the dovetailed piece *D*, and which are about 1/16 inch longer than *D*, are placed in the holes, after which *D* is fastened in place by driving in the key *E*. The ram is then let down with the result that the projecting centers of the punches mark the top of the die *B* at points concentric with the holes. These centers are then used to lay off holes in the upper die, which are drilled and tapped for the bolts.

The efficiency of the steam-hammer for doing pressed steel work, is shown by the following figures: The three frame members *G*, *I*, and *K* were pressed at a cost of 9 cents per set. Three laborers can press five hundred of the pieces *I* in ten hours, one man running the hammer, one keeping the pressed parts out of the way, and one placing the work in position. This same hammer is also used for doing some heavy and difficult pressed steel work for boilers. T. O. MARTIN

Jackson, Tenn.

EFFECTIVE METHOD FOR HOLDING RACK ON PLANER

Some readers of MACHINERY may recognize in the following an experience similar to one of their own. I was running a planer which had a rack built in two pieces, and as usual, it was held by screws counterbored in the middle slot of the table. The normal condition of these screws was about half a turn loose and although securely tightened, they persisted in working back to normal, in which state they had worn elliptical holes so that a comfortable little "chug chug" was emitted at the end of each stroke. This continued until one day when the screw sheared off, the table stopped and the rack slid off on the floor. Now at last the machine had to be repaired, but instead of drilling out the holes and setting new



Figs. 1 and 2. Punching to be swaged and Section of Die

screws, I decided to put in new ones of the same size and let the driving thrust be taken by keys. This was accomplished by cutting two half-inch keyways in each section of the rack and corresponding ones in the table. After putting in the new screws, the keys were carefully fitted and the planer was again ready for business.

On the face of it this planer construction, which is so common, seems to be in defiance of theory—relying on bolts under tension to resist the lateral stress which would be caused by the thrust of the cut. Yet in the majority of cases this manner of holding the rack has been effective. Possibly it has no parallel in machine tool design.

Middletown, N. Y. DONALD A. HAMPSON

LAPPING A SIZING AND SWAGING DIE

A die was required for swaging and burnishing pieces of mild steel which had been punched to the shape shown in Fig. 1. These pieces measured about one inch long, across the wide part, ¾ inch the other way and they were about 5/32 inch thick. As they were rough after being blanked out in the press, a die was needed for sizing and burnishing the irregularly-shaped edges. A sectional view of this die is shown in

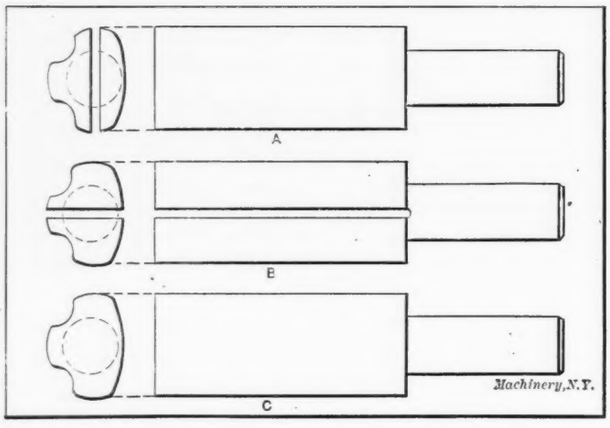


Fig. 3. The Three Laps used for the Die shown in Fig. 2

Fig. 2. The hole through it was made perfectly straight for about ⅝ inch from the top, the remainder of the hole being relieved or enlarged as shown. The two edges *e* were then beveled sufficiently to leave about 5/16 inch of the hole straight and smooth. This die was made as hard as possible around the hole, after which it was heated just enough to ease any internal strains which may have existed. As the hole shrank quite a little it was necessary to lap it to size.

Three cast-iron laps of the shape and size the hole was to be, were made for this operation. These laps, which are shown in Fig. 3, were two inches long and were provided with a ⅜-inch round shank about one inch in length. Two of the laps, *A* and *B*, were slotted, one across the wide part and one across the narrow way as shown. The third lap *C* for finishing, was left solid.

A small Dwight-Slate drill press which was in the shop was used for the lapping operation. One of the split laps was first caught in the drill chuck and the lapping done by working the spindle lever by hand. This method, however, proved too slow so it was decided to rig up the drill press so that the reciprocating movement necessary could be obtained by power from the machine. The way the required motion was transmitted from the driving pulley shaft to the spindle of the machine is shown in Fig. 4. A crank *A* was attached to the shaft and this was connected to the arm *C* by rod *B*. As the pulley shaft only projected ⅛ inch beyond its bearing, it was necessary to drill and tap it, for a ⅝-inch stud on which to mount the crank. Lever *C* was attached to the screw or stud in the spring-case *D*.

After the parts were connected, the die was placed on two parallel strips on the drill press table. The lap was held in the drill chuck as before, and the lapping done by using carborundum flour and oil as an abrasive. It will be seen that with the driving pulley connected to the drill spindle as shown, the latter is given a vertical movement up and down. The slotted laps *A* and *B*, Fig. 3, which were expanded by the use of wooden wedges, were used first. By changing the split laps and using first one and then the other, the hole was soon lapped practically to size. The solid lap was then used to finish the hole, which completed the die.

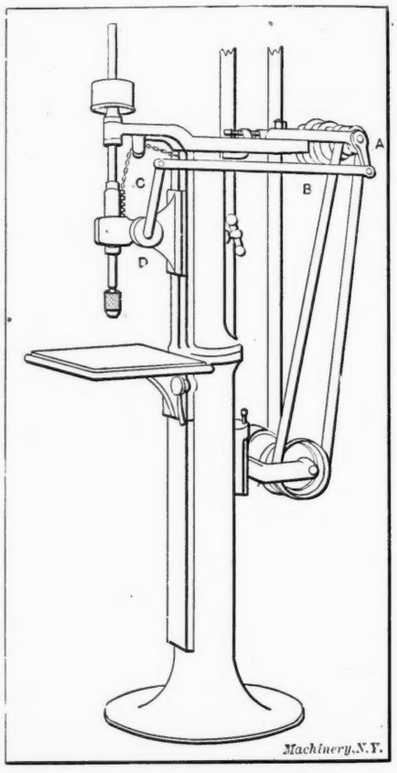


Fig. 4. Drill Press arranged to give Reciprocating Movement to Spindle for Lapping

Those who have not had experience in die work might be interested in knowing how these laps were made. First the approximate center of a sample punching was found, and a ⅜-inch hole drilled through it. Then an end was turned on the rough cast-iron laps to fit the hole and long enough to go through the punching. A smaller hole ⅛ inch in diameter was then drilled and into this a pin was inserted to hold the punching in place. The lap was then inserted between the centers of the milling machine and milled approximately to the required shape, the sample being used as a guide. In this way the laps were roughed out so close to the required shape that little filing was needed. A. S. GUN

GRAPHITE CUTTING COMPOUND

Although there are so many new things on the market, all said to do some particular work better than anything else has ever done it, and though there are so many of those so-called panaceas that one has not time to even read about them, much less try them, we think it will be interesting to readers of MACHINERY to know of some remarkable performances which have been obtained from the use of a new and unique product. We refer to the graphite lubricant, "Aquadag," used as a cutting compound.

Some weeks ago we were cutting off in the lathe a large

number of cold-rolled steel rods averaging about 1 inch diameter. Records showed that the average number of cuts made by the cutting-off tool with one sharpening was 60 when using an ordinary soap cutting compound. Having had a sample of deflocculated graphite [see MACHINERY, July, 1907] presented to us we mixed a small amount of it with our cutting compound, and were as much astonished as gratified to find that the tool did not blunt anything like as rapidly as before. In fact the cutting-off tool actually made 980 cuts with only one sharpening. Fig. 1 shows 60 cuts made, representing the maximum that could be done with the plain compound, and Fig. 3 shows the 980 cuts made by the same tool in the same machine, the only difference in conditions being the addition of the graphite to the cutting compound. One also notes that not only did the tool in the second case do about 16 times as much work as in the first, but also that the ends were very much smoother, that is, the work was done much better.

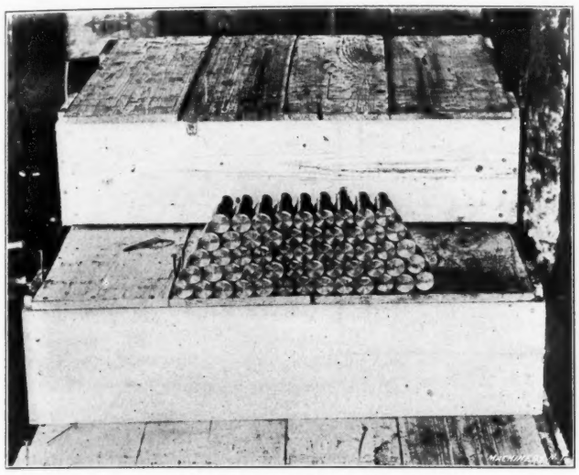


Fig. 1. Sixty 1-inch Cuts made with Plain Compound

We have also used "Aquadag" for many other machine tool operations with the same good results. For instance, in boring and reaming a large number of holes in bronze bushings we find that with our ordinary cutting compound the hole is always about 0.0002 inch smaller than the reamer used, but, through the addition of Aquadag to the compound, we find that we can cut a hole practically the full size of the reamer, this again being a conclusive argument that graphite greatly increases the cutting possibilities of the tool. We have also been enabled to effect considerable reduction in power consumed. We have in our factory a machine for a certain operation in which it was necessary to run with the back gears when using an ordinary cooling compound. However, by the above mentioned addition of graphite to the compound we ran with open belt. One sees here not only a reduction of power consumed by the cutting tool but also that an increase of speed is made possible.

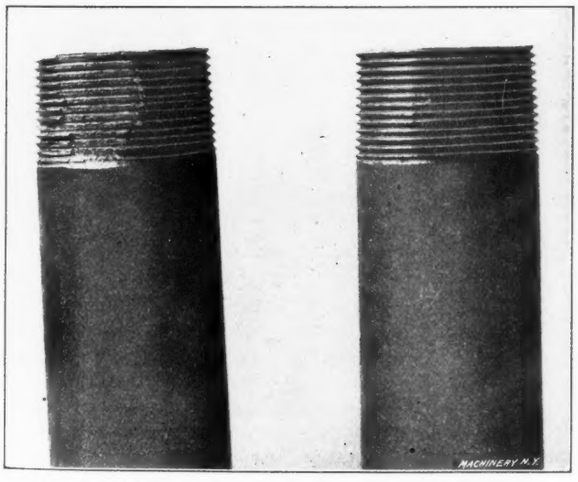


Fig. 2. Left-hand Pipe Thread cut with Lard Oil and Right-hand Thread with "Aquadag" using same Die

As yet, our experience with this product has been somewhat limited; in fact, it was only a few weeks ago that we commenced to use it, but so far, the results show a very much better operation, whether it be in the lathe, for turning or cutting off, or whether it be for milling or thread cutting, than could be obtained without it. Personally we are quite interested in this idea of using deflocculated graphite for a machine-tool lubricant and we shall be glad to hear of the experiences of other readers who may experiment with the same. We should mention that "Aquadag" is a mixture of pure graphite and water, made by the International Acheson Graphite Co., Niagara Falls, N. Y., the graphite contained being so extremely fine that it will feed through a fountain pen and will remain permanently suspended in water.

Niagara Falls, N. Y. NIAGARA MACHINE CO.

A SPLINE MILLING FIXTURE

The description and illustrations of the jig for slot milling long, slender work, published in the March number of MACHINERY by Mr. O. R. Barrett, reminds me of a somewhat similar device designed some time ago for spline milling steel shafts. This fixture contains several improvements over that described by Mr. Barrett, which is open to the following criticism:

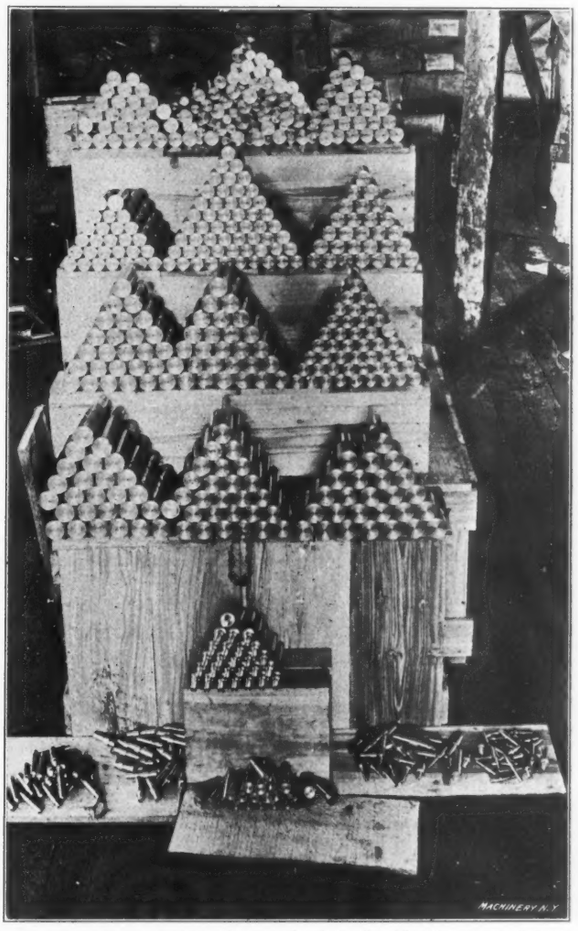
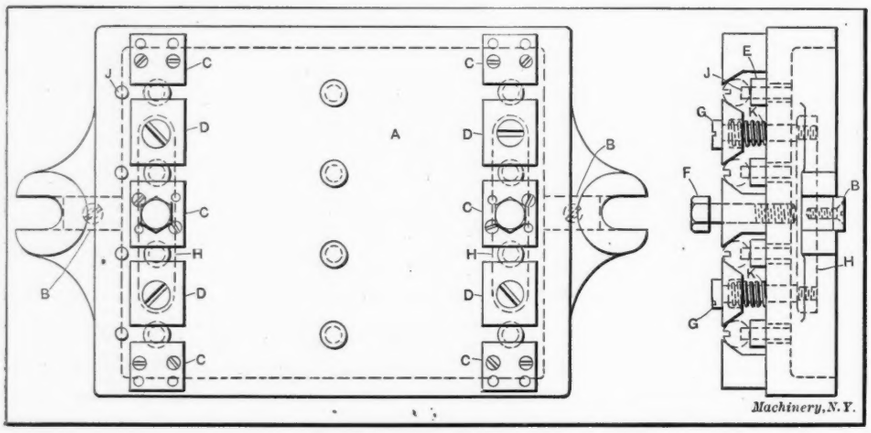


Fig. 3. Nine-hundred eighty Cuts made with "Aquadag" as the Lubricant

In the first place, the pins upon which the work rests between the clamps, are "blind driven" into the base casting, rendering it extremely difficult to remove them when it becomes necessary to renew them on account of wear. Besides, pins of this character taking the thrust from a clamp, should be made with a substantial shoulder, as it is much easier to get them all to the same height above the base surface.

Another weak point in this device is that four nuts must be turned, in order to clamp the four castings, while a little additional thought on the subject would have shown that this could have been accomplished by means of two bolts and a pair of equalizer bars, as will be described later when considering the spline milling fixture.

I also notice that the various blocks, against which the clamping action takes place, are not doweled in position, and while this may be an oversight in the drawing, and was undoubtedly taken care of by the toolmaker, it should not be forgotten that dowel pins are what really hold a block in accurate location and that the screws merely serve to clamp the block against the base and to resist any upward or tilting thrust which may exist; consequently, the two screws which hold the outer blocks, should be placed side by side, close to the inner or clamping edge of the block, and the dowel pins should be placed behind the screws, as shown in the accompanying illustration.



Fixture for Spline Milling Shafts

The fixture referred to for spline milling steel shafts consists of a cast iron fixture base, which is provided with steel tongues *B*, to engage the groove of the milling machine platen. Hardened tool-steel blocks *C*, mounted on the base casting by means of fillister-head screws, and dowel pins, serve as blocks against which the work is clamped, and it should be noticed that the surfaces of these blocks, as well as the surfaces of the clamps *D* are straight, in order that the work being clamped will not be mutilated by the pressure being concentrated at one point of contact. [The advantage of having clamps with a single point contact for holding long, slender and rough work, is that there is less danger of springing it. This point was carefully explained by Mr. Barrett.—EDITOR.]

The clamps *D* are of machine steel, carbonized and hardened, and are counterbored from the under side to receive the helical springs *K*, which serve to release the clamp by their upward pressure. These clamps are actuated by the casehardened steel screws *F*, which are threaded through the base casting and bear against the middle portion of the equalizer bars *H*. These bars are of machine steel, carbonized and hardened, and carry at their extremities screws *G*, which pass through the clamp blocks *D* and serve to pull them against the work when the operating bolt *F* is turned.

The work rests upon hardened tool-steel pins *E*, which are driven into the base against a shoulder, and the end thrust of the cutter is absorbed by the steel stop-pins *J*. A socket wrench is used to operate the clamp bolts *F*.

It will be noticed that this fixture is much more rapid in its operation than Mr. Barrett's yet it accommodates the same quantity of work, and costs practically the same to build.

C. NOSRAC

SETTING A BENCH LATHE SLIDE-REST FOR STRAIGHT GRINDING

To set the slide-rest of a bench lathe to grind parallel, a cylindrical test piece having centers in each end and a collar on one end, may be used and accurate results obtained. The collar is first ground true, after which the position of the test piece is reversed. When the emery wheel is moved up to the other end, its position with relation to the collar as indicated by the sparks, will make it possible to set the slide-rest very accurately, though it may be necessary to repeat this cut-and-try method once or twice.

For inside setting when finishing holes by grinding, particularly when the work is hardened and is to be lapped, it is especially desirable to get the hole as nearly parallel as possible. This may be done by feeding the emery wheel through the hole and making it cut first on one side and then on the other. By noting the sparking of the wheel, the slide can be set so that the hole can be ground parallel, to an extreme degree of accuracy. If the hole is very deep or small in diameter so that the sparks cannot be seen, a "listener" is used which consists of a piece of a small drill rod with a handle on one end. The end of the rod is applied to some part of the grinder and the handle is held close to the left ear. By the sound emitted when the wheel is in contact with the work, it is easy to tell if the cut is the same throughout the length of the hole on both sides. If this "listener" is not sensitive enough, the bottom of a tin can (having one end open) may be applied to some part of the grinder or to the top of the tool-post screw. The contact of the emery wheel with the work can then be easily heard by listening at the open end of the can, even though the wheel is not taking a cut deep enough to make a visible mark in the hole.

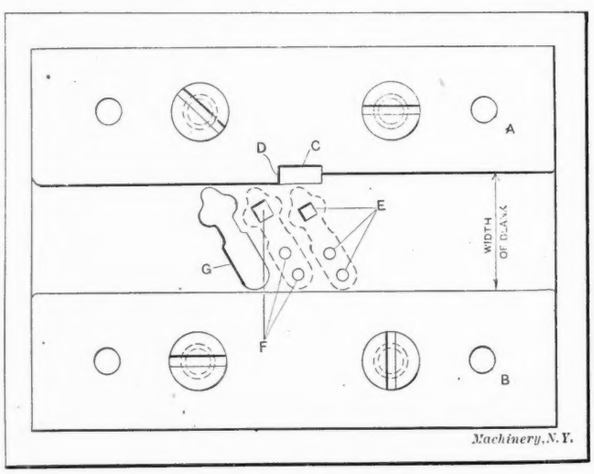
These methods are not only better, but far quicker than the old way of calipering for parallelism.

A. L. MONRAD

East Hartford, Conn.

FEEDING DEVICE FOR PUNCH PRESSES

Seeing an article on feeding devices for punch presses in the April issue of MACHINERY brought to my mind a feeding device which I have used to good advantage when the feeding space was not more than one inch long. The accompanying sketch shows clearly the method used. *A* and *B* are the two guide strips which are fastened to the die blank as shown. The stock is cut the required width to slide in between the guide strips. The punch which is inserted in hole *C* in the die shaves off one side of the strip, allowing it to be located at the point *D*. Holes *E* are used for piercing the piece and holes *F* are made large enough to clear the pierced holes which are embossed and not clean cut. The blank is then punched at *G*. After feeding the stock in to the die, from right to left, until the end projects past the opposite end of the die, the stock can be grasped by the hand and drawn through the die, the point *D* acting as a stop. One advantage of this feeding device is that no pilots are required on the punches for spacing accurately. It should be mentioned that it is not advisable to use this device for blanks requiring a feed of more than 1 inch.



Feeding Device for Small Blanks

CHARLES PABESHUTZ

Milwaukee, Wis.

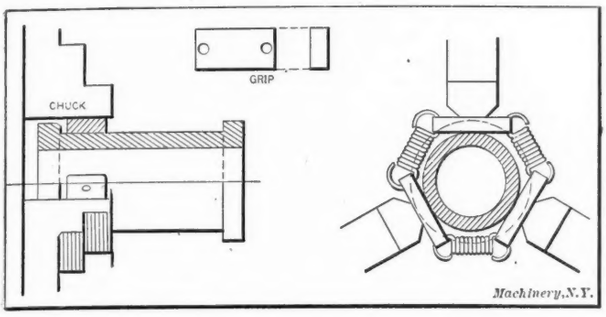
SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary

CHUCK GRIPS FOR FLANGED WORK

Three or four strips of bar stock, drilled at each end, and hooked together with coil springs, as illustrated in the accompanying engraving, make handy grips for holding

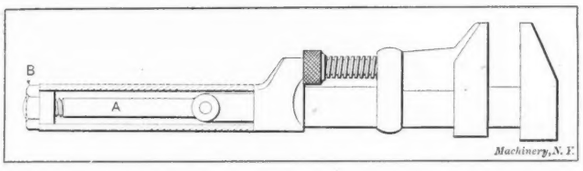


flanged bushings, etc., in a chuck. The number of grips required will, of course, depend upon the type of chuck used. Grips 5-16-inch thick, ⅝-inch wide, and 1¼-inch long are a handy size. CHARLES E. BURNS

Beverly, Mass.

HANDLE FOR MONKEY-WRENCH

The way the broken handle of a 12-inch monkey-wrench was replaced with a strong iron one, is shown in the accompanying illustration. The only material required was one



piece of pipe 1 inch by 4½ inches long, and one ⅜-inch steel bolt *A* with a slot cut in the end to fit the tongue-piece of the wrench. This bolt was fastened by a pin as shown, and the nut *B* served to hold the handle in place. W. F. OLIVER

Plainfield, N. J.

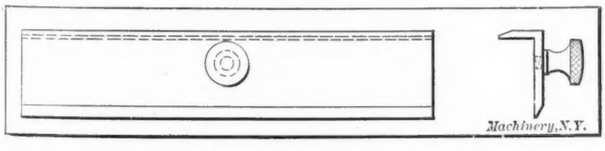
STARTING A DRILL

In the "Experiences of a Young Toolmaker" in the December number of MACHINERY "George" tells "Jim" that he does not need a centering tool. George is right about the centering or spotting tool, but if he and Jim will use the drill with the lips vertical instead of horizontal, they will find it will not have so much tendency to travel up and down and will take its central position more readily. J. R. RAND

Springfield, Mass.

BOX-SQUARE WITH HOLDER

Probably every machinist has had trouble, at times, in holding a box-square securely on the piece of work to be marked. I have found it so troublesome to hold while using, that I de-



cided to have some sort of a handle attached to it, so I drilled a hole in the center of the broad side and tapped it out for an ordinary thumb-screw which happened to be at hand. After filing the end of the screw even with the inside, the holder was finished. The illustration indicates so plainly the advantage of this little screw that further explanation is unnecessary.

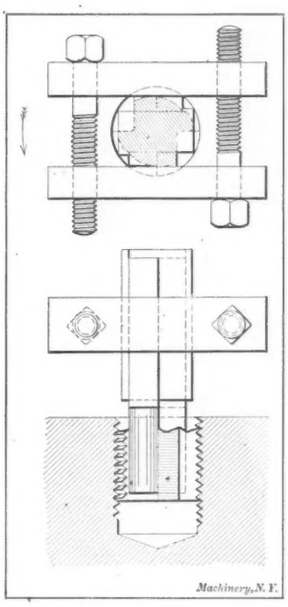
New York City. ARTHUR BLOFIELD

HOW TO PUT A TAP IN STRAIGHT

Recently the apprentices at our shop were asked at an examination, how they could tell whether a tap is going in straight or not, if the hole being tapped passed through the center of a sphere. The answer was, by securing a faced nut over the tap and down against the work. If it touched evenly all around this would indicate that the tap was going in straight. CANADIAN PACIFIC RAILWAY APPRENTICE.

MAKING SMALL EMERY WHEELS FROM BROKEN PARTS

If an emery wheel breaks, small wheels may be made from the pieces by drilling a hole in the center of each piece for the arbor and trimming the part to a true circular shape. The center of the broken part should first be found and then a circle drawn equal in diameter to the size of the wheel. The hole should then be drilled for the arbor and the piece ground to shape on an emery wheel. When it is nearly round, it can be finished by mounting it on the arbor of a small wheel-stand, and dressing the periphery with a diamond tool. When drilling the hole, the drill press can easily be driven by hand; it should run slowly, say from 10 to 20 revolutions per minute, and water should be used on the drill. In this way a perfect hole is drilled and the drill itself is uninjured.



JOHN C. MONRAD

Buffalo, N. Y.

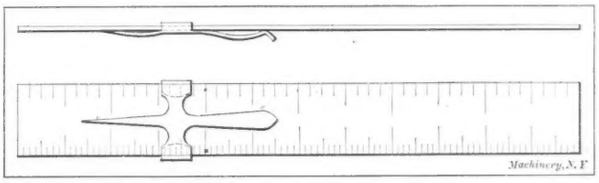
A TAP EXTRACTOR

The illustration shows a device for extracting a broken piece of tap from its hole. Take a couple of steel strips, either square or rectangular, and file them part of the way, up to a curved shape, as seen dotted in the plan. Prepare a piece of steel with slight ledges on opposite sides, and bind the strips to this by means of a lathe dog or clamp, as shown. The thin, wedge-shaped ends will pass down the opposite flutes of the tap, and catch against the lands when the rig is turned to the left, thus unscrewing the bit of tap. FRED HORNER

Bath, England.

COMBINATION SCALE AND SCRIBER

The accompanying illustration shows a 6-inch scale to which is attached a scriber that is made of tool steel. This scriber



also acts as a pocket clip; in fact, that is the purpose for which it was originally designed. As a scriber is mostly used with the scale, the upper part of the clip was extended so as to form a scriber point, thus combining two tools in one.

Cleveland, Ohio. A. NIELSEN

PUMPING HOT WATER

Hot water, even up to 180 degrees F., may be lifted about ten feet if the following piping is run: At the point where the vertical riser from the well meets the horizontal suction pipe to the pump, instead of an elbow use a tee, and on the run of the tee extend the vertical pipe for about four feet and cap it over. If the lift is not too great, this will operate satisfactorily. R. E. BRADLEY

Winchester, Mass.

HOW AND WHY

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published

INFLUENCE OF BELT THICKNESS ON PULLEY SPEED

R. D.—Should the thickness of the belt be taken into consideration when calculating pulley speeds?

A.—When the diameters of the pulleys are small and the belt is relatively thick the thickness of the belt should be taken into consideration in pulley speed calculations, more particularly so when the difference of the two pulley diameters is great. In ordinary pulley calculations, however, where the pulleys are, say, twelve inches in diameter or more, it is not customary to consider the thickness of the belt. In the case of a feed belt of an engine lathe, the thickness of the belt makes an appreciable difference in the ratio of the pulley speeds. If the driving pulley is, say, 6 inches in diameter and the driven pulley is 2 inches in diameter, then the ratio of the driving and driven diameters, not considering the belt, would be as 6 to 2, or as 3 to 1. Considering the thickness of the belt, however, to be ¼ inch and taking this thickness into consideration, the ratio would be as 6¼ to 2¼ or as 2.77 to 1. It will therefore be seen that the thickness of the belt makes a difference of about 8 per cent in the speed of the driven pulley.

CRUCIBLE FURNACE CONSTRUCTION FOR GAS FUEL

W. R.—I enclose a sketch of a crucible furnace, see Fig. 1, with which we are having no end of trouble on account of the rapid burning out of the cast-iron gas burners. The furnace is used for casehardening small steel parts. Gas is burned under moderate air blast from the shop line. We would appreciate some solution of the difficulty.

Answered by E. W. Beardsley, Waterbury, Conn.

A.—In Fig. 2 at *A* I have reproduced your sketch of the furnace and crucible, adding a cover, a vent at the top, and a

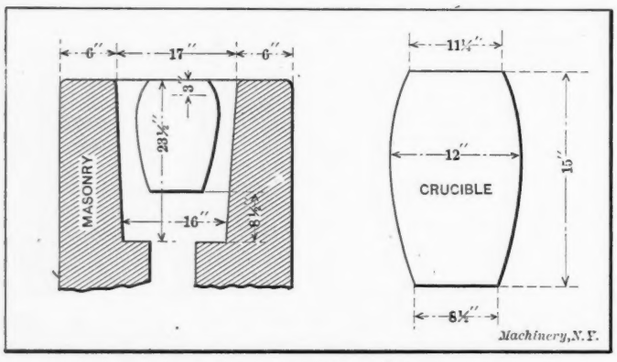


Fig. 1. Furnace Construction which gives Trouble with Burners

burner at the bottom, as illustrative of the probable present construction. The burning out of the cast-iron burner is probably due either to the large surface exposed to radiation from the furnace chamber, or to combustion taking place inside of the burner, on account of faulty design or operation.

At *B* is shown a much better application of burners, which, in a furnace of this size, should probably be not less than two in number. At *C* is a sectional plan of furnace *B*, showing more clearly the tangent relation of the burners to the circular chamber. With this arrangement the flame will probably travel several times around the crucible instead of taking as nearly as possible a straight line from the burner to the vent, as at present.

At *D* is shown a section of a burner which can be made up from standard pipe fittings. If the tip burns out, as it probably will in time, the flange joint enables easy removal and the burned parts can be cheaply and easily replaced. Use a gasket of asbestos paper or similar material between the flanges. Fittings for 1½-inch wrought-iron pipe will probably be large enough for your furnace with two burners, and a 2-inch pipe will be sufficient to bring the gas and air from the mixer to the tee supplying the burners.

If the "shop line" from which the air is taken carries compressed air at a pressure of 40 pounds per square inch or more, the air should be used in a jet blower, for economy. The one shown in Fig. 3 is a combined jet blower and mixer which can be easily constructed from pipe and fittings. These fittings should be not smaller than 2-inch pipe size for the cross, 1½-inch pipe for the gas, and ⅛-inch or possibly ¼-inch for the compressed air. The pressure beyond the mixer need not be more than 2 pounds per square inch, and probably 1 pound will be sufficient.

The changes recommended would probably result in a saving of not less than 10 per cent and very likely 25 per cent of the

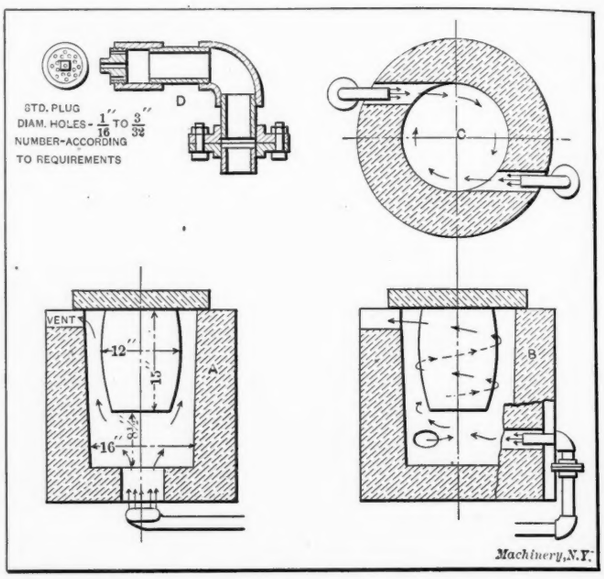


Fig. 2. Suggested Improvements over Furnace A are shown at B, C and D

gas you are now using. With a suitable furnace using fuel oil or coal instead of illuminating gas, you could probably save not less than 60 per cent of the present fuel cost. If in a coal or oil furnace you would use a cast-iron box in place of the crucible which is the usual practice, the saving would probably be 80 per cent or even 90 per cent.

Suitable furnaces for casehardening with any of these fuels can be bought from various manufacturers whose advertise-

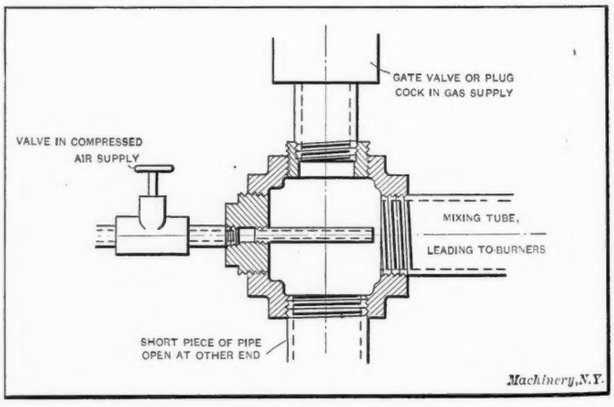

GATE VALVE OR PLUG COCK IN GAS SUPPLY
VALVE IN COMPRESSED AIR SUPPLY
MIXING TUBE, LEADING TO BURNERS
SHORT PIECE OF PIPE OPEN AT OTHER END
Machinery, N.Y.

Fig. 3. Combined Jet Blower and Mixer Operated from Shop Compressed-air Service

ments you will find in this paper, at a lower cost than you can make one yourself. You can probably also buy suitable gas burners alone, from the gas furnace manufacturers.

* * *

Some concerns in certain lines of manufacture requiring many comparatively simple and cheap special machines, make a practice of purchasing second-hand machine tools. The headstocks and slides are worked over at small cost so as to adapt them to the desired purpose. Many special machines are in use in a certain factory, built up from regular machine tools at very low cost, the functions of which are quite different from those for which the machines were originally designed.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

Comprising the description and illustration of new designs and improvements in American metal-working machinery and tools, published without expense to the manufacturer, and forming the most complete record of new tool developments for the previous month.

MORTON TRAVELING-HEAD CYLINDER PLANER

The traveling-head cylinder planer illustrated herewith, which is built by the Morton Mfg. Co., Muskegon Heights, Mich., is a machine that is particularly adapted to that class of work which, when finished with standard tools, requires, in some instances, more time for adjustment than in the actual machining operations. As this machine, besides being an efficient planer, is also capable of performing boring and milling operations, parts can often be finished at one setting, thus effecting a considerable saving in time.

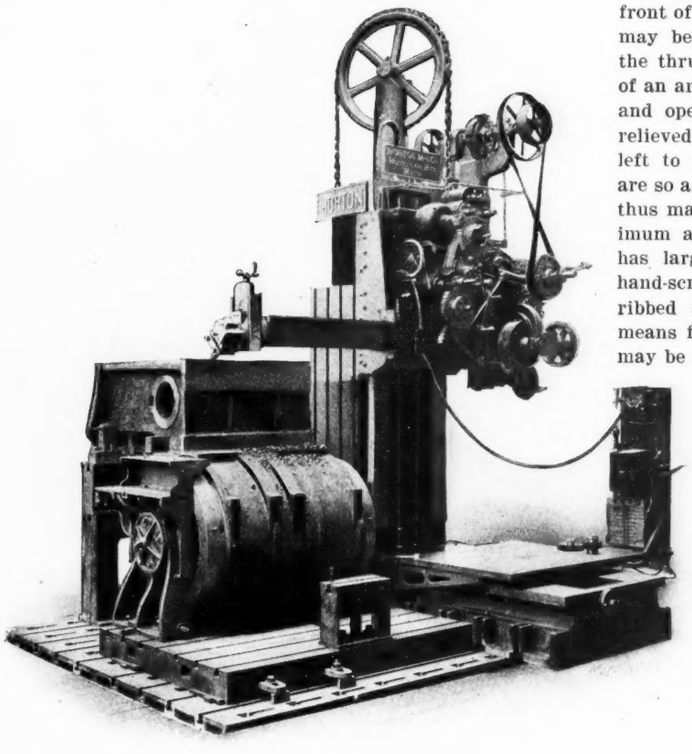


Fig. 1. Morton Traveling-head Planer with Locomotive Cylinder in Position for Planing

This planer is electrically driven by a 10-horsepower variable speed motor, which is attached directly to the base of the column. The power is transmitted through gears to a vertical shaft which is connected with the directly-attached countershaft. From this shaft connection is made by open and cross belts to friction clutch pulleys, which control the reciprocating motion of the ram, and are so arranged that reversals are made without shock or jar. By means of a clutch, the countershaft may be stopped and started independently of the motor and it can be reversed for back-facing, boring, etc., when necessary.

The vertically moving apron which is closely fitted to the column and provided with means for compensating for wear, carries the feeding and other working mechanism of the machine. This slide is provided with taper gibs and is so constructed that it is unnecessary to employ binder clamps back of the bearing rails. The saddle casting is extended in such a manner that in connecting with the taper gibs, it forms a bearing which insures rigidity. The counterbalance for the apron and its mechanism consists of an air cylinder placed on the rear side of the column, in which a given pressure is automatically maintained. A compressor, which is driven direct from the motor, makes the machine independent of any outside connection.

The column and its saddle are made in one piece and are heavily constructed throughout. The T-slotted plate on the front of the column presents a surface against which a bearing may be bolted for supporting high work, thereby bringing the thrust of the cut directly against the column. By means of an anti-friction carriage which is placed beneath the column and operates on a steel track, the bearings on the bed are relieved of a certain portion of the weight, just enough being left to insure the machines working steadily. Coil springs are so arranged that the tension can be increased or diminished, thus making it possible to adjust to the point where the minimum amount of power is required for operation. The bed has large bearing surfaces and square bearings which are hand-scraped and fitted. It is very rigidly constructed, being ribbed and cross-ribbed. Open slots on each side provide means for screwing the bed to the floor-plate by bolts; these may be easily removed, making the machine portable.

The cast-steel ram is made hollow and square and it has a bearing on all four sides which extends through the entire length of the apron. Provision is made for taking up wear by wedge gibs above and by the adjustment of a ram cap on the side. Power is applied to the ram by a rack and pinion movement. The main driving pinion and bevel gears are made of steel and are so arranged that they are entirely enclosed and run in oil, thus insuring practically noiseless operation and great durability. The gearing is all cut from the solid. The stroke of the ram may be quickly adjusted by tappets on a circular disk. The minimum stroke is 3 inches and the

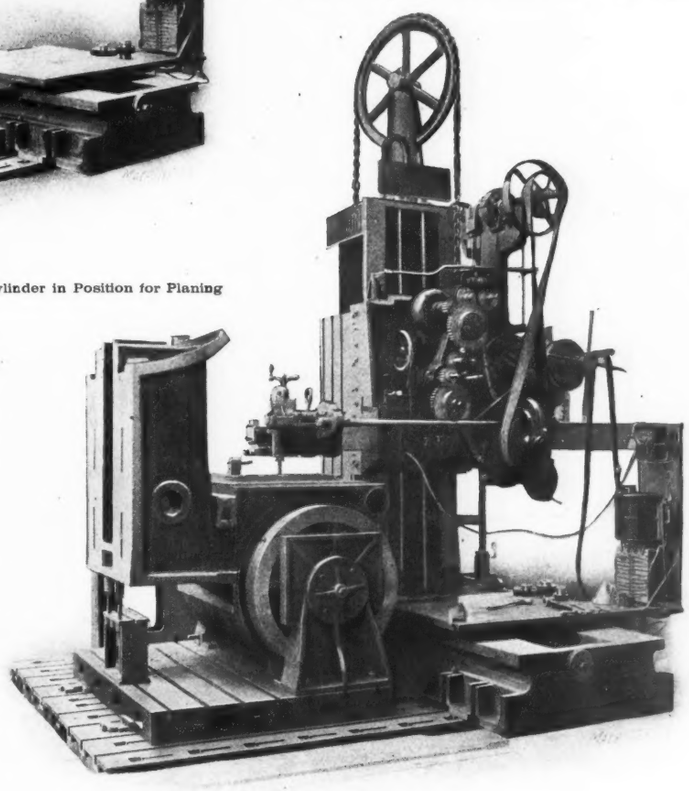


Fig. 2. Morton Cylinder Planer equipped with Port Milling Attachment

maximum 48 inches. The head of the ram is made entirely of steel, and is provided with special steel clamps. It is graduated for planing to angles, and the clapper-box is arranged to relieve the tool on the return stroke.

The feed is a new design of the compound disk friction type, the disks of which are lined on each side with vulcanized fiber. It is of the automatic relieving type and is provided with an instantaneous quick change by adjusting tappets on a circular disk containing holes so that the tappets may be securely locked in position. The feed is reversible so that it may be made to occur at either end of the stroke. When the full feed is required, the tappets may be so arranged as to cause it to operate at both reversals. The feeding mechanism for milling and boring consists of a special feed box secured to the vertically moving saddle, which gives ten changes, covering a range suitable for either boring or milling. Provision is made for reversing so that the saddle may be fed vertically in either direction and the column horizontally in either direction. The ram may also be fed in and out and the arrangement is such that all boring and milling feeds are stopped and started with one lever. The feed screws are of large diameter and the feed nuts are all of bronze and of the revolving type. They have long bearings on the screws and are provided with ball bearing thrust collars with hardened steel plates.

This machine is provided with an auxiliary table 30 inches high, 36 inches wide and 8 feet long, which may be bolted to the floor-plate. By means of parallel strips which may be placed between the bed and the lower edge of the table, the latter can be set in perfect alignment with the bed. It can be used for holding parts being planed or, as illustrated in Fig. 3, in connection with rotary planing.

The milling and boring attachment is provided with a hollow steel arbor which passes through the ram and is journalled in bronze bearings. The front bearing is tapered and adjustable for wear. A special steel yoke which is attached to the back end of the ram, carries a powerful train

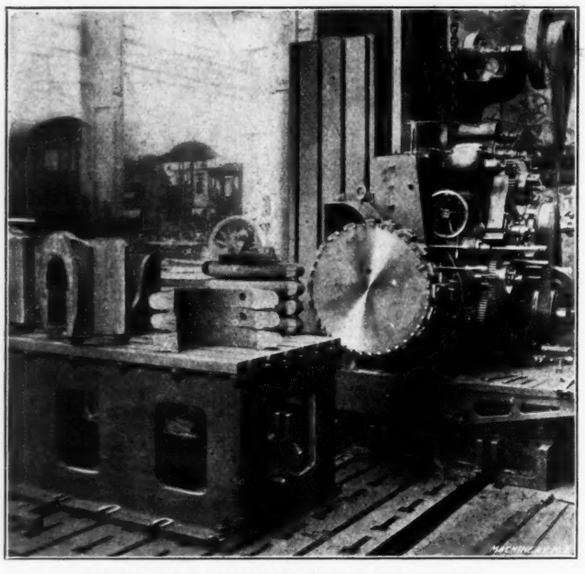


Fig. 3. Cylinder Planer Arranged for Rotary Planing

of gearing for driving. This yoke is so designed that it may be quickly removed with the gearing when necessary. The arbor is bored for receiving taper shank milling cutters, boring-bars, etc., and a retaining or drawing-in bolt which passes through the arbor makes it possible to quickly engage or disengage the tools. The rotary planing equipment consists of a steel milling head about 25 inches in diameter provided with an internal gear, the teeth of which are cut from the solid. The cutters are inserted in the periphery as shown in Fig. 3, and securely clamped.

The port milling attachment, which is shown in use in Fig. 2, may be quickly attached to the squared section of the ram without removing the shaper head. It is provided with a vertical arbor and a train of gearing giving ample power. The spindle is bored to receive a No. 4 Morse taper. This is an efficient attachment for milling cylinder ports, and the operation may be performed when the work is in position for planing the valve seat.

The cylinder chucks, the use and advantage of which will be apparent by referring to Figs. 1 and 2, are attached to movable brackets which are tongued and fitted to one of the slots in the auxiliary base-plate. One of these brackets may be adjusted by a rack and pinion for cylinders of different lengths. These brackets are made to given dimensions so that their surfaces may be used in laying out lines. The chucks are of the three-jawed universal type and make it possible to quickly set a cylinder in alignment, as the jaws

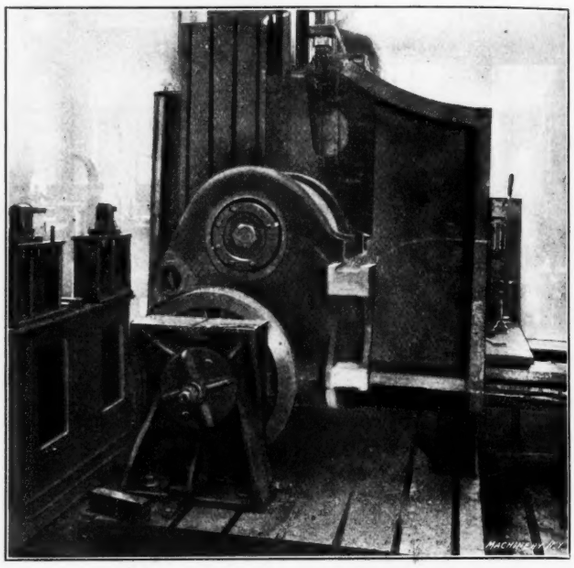


Fig. 4. Boring Attachment of the Cylinder Planer in Use

engage with the finished counterbore. A bolt passing through the cylinder from one bracket to another more firmly aligns and holds in position the work. Parallel blocks are included for supporting a cylinder in various positions and when the work is once chucked, it is not removed until the planing is finished and the bars milled.

This machine has a longitudinal feed of 9 feet and a vertical feed of 60 inches. The extreme height of the machine is approximately 15 feet, the floor space required 14 by 16 feet, and the weight 48,000 pounds.

NEWTON BOLT THREADING MACHINE

The Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa., has brought out an interesting type of bolt threading machine which we illustrate herewith. This machine, which is built with the duplex die-head shown in Fig. 1, or with a single die-head, has been designed to handle the diversified class of work that the bolt-cutter is usually called upon to do.

The compact design of adjustable die-head with which this bolt-cutter is equipped, constitutes one of the most interesting features in its construction. These die-heads are fitted with four different sets of chasers, as shown in Fig. 2, so that a single head is always ready to cut any one of four bolt sizes. The chasers are of a standard form and are accurate and interchangeable. The four chaser blocks in which the chasers are fitted, are operated universally when adjusting the die, and each is independently locked in its position by a special arrangement which prohibits any movement whatsoever.

To index the chaser blocks when setting the die to a different size, it is simply necessary to throw the lever controlling the head back far enough to completely disengage the locking mechanism; a pin is then inserted in any one of the chaser blocks, which, together with the others, is revolved to the desired position. The head is then closed by means of a lever, and a hand-wheel is adjusted until a pointer is in line with the zero mark on the scale covering the particular size required. By means of separate index scales for each posi-

tion of the chaser blocks, the dies may be set so accurately that it is not necessary to cut trial bolts except when a chaser is first put into operation or when it has been re-hobbed. After the chasers are once set, the head can be indexed as frequently as desired and it can always be brought to the correct position by the pointer and scale referred to. Chasers of the "hobbed" type will be furnished unless otherwise specified, owing to the fact that many desire to re-hob and make their own chasers. These chasers are made of carbon steel ordinarily, but will be made of high-speed steel if preferred.

The general construction of the die-head is simple, there

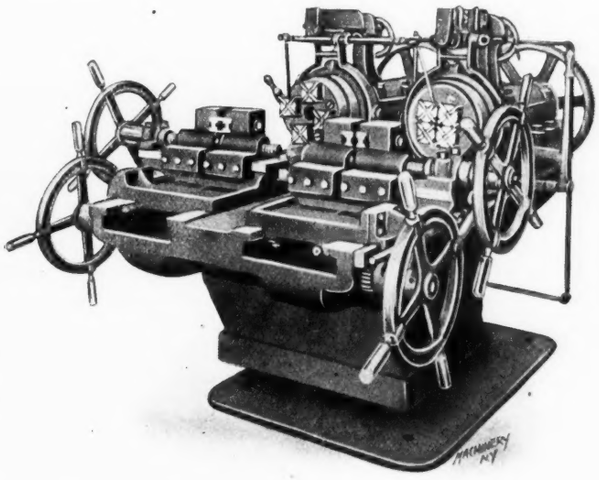


Fig. 1. Newton Duplex Bolt Threading Machine, with Multiple Automatic Die-heads

being few operating parts, all of which are of high-grade material. The head is arranged for automatic opening and closing, or it can be operated by hand. The construction is such that when the opening is done automatically, no fin or burr is left on the thread. The makers claim that this head is as rigid as a solid die, owing to the fact that the in-and-out motion is controlled by a cam and eccentric which give a solid metal-to-metal contact, so that the die is absolutely dependable in maintaining the size of bolt when it is once set. The die-holders are of 50-point carbon steel and the chasers are fitted into slots milled from the solid and have bearings on two sides and the end. The chasers are held in place by a single screw, as shown, and are interchangeable.

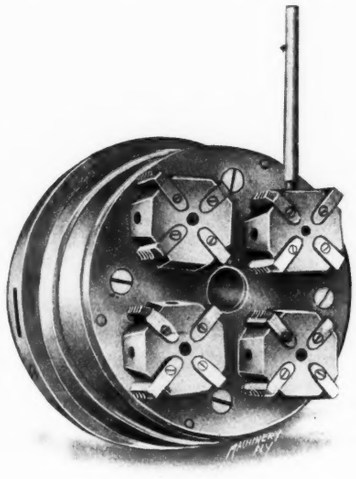


Fig. 2. Multiple Die-head Open ready for Indexing to Different Size

The die-heads are made in two sizes designated as Nos. 1 and 2. The first size will cut $\frac{5}{8}$, $\frac{3}{4}$, $\frac{7}{8}$ and 1-inch bolts, and the No. 2 size, $1\frac{1}{4}$, $1\frac{1}{2}$, $1\frac{3}{4}$ and 2-inch bolts. As the spindle of the machine is hollow, any length of thread may be cut. The duplex machines are made in one size only, and are fitted with heads of each size, thus giving them a capacity for cutting bolts of eight different diameters ranging from $\frac{5}{8}$ inch to 2 inches. The single machines are made in two sizes with either the No. 1 or No. 2 size of die-head.

In its general construction, this machine is heavily built throughout. The carriage is provided with compensation for wear so that alignment can be maintained, and all operating parts of the head are fully enclosed so that all dirt is excluded. The clamping jaws of the vise are reversible and interchangeable, and the machine is fitted with a pump, chip box and drip pan.

NEWCYCLE GAS AND OIL ENGINE

An interesting type of internal combustion engine has recently been placed on the market by the Newcycle Motor Co., 39-41 Cortlandt Street, New York City. The main purpose in the development of this new engine, one design of which is illustrated herewith, has been to secure the advantage of an explosion at each revolution, as with the ordinary two-cycle type. It is also designed to give perfect scavenging without waste of fuel and a full charge of explosive mixture for each revolution.

In the operation of this engine, air only is taken into the crank-case on the up stroke of the piston, through a check valve screwed into the opening *N*, Fig. 2. It will be noted that the piston has two diameters, the smaller end working in the power cylinder and the larger diameter acting as a pump piston, which serves to draw air into the crank-case *C* and also to compress the charge, which is done in the annular space *B* above the enlarged piston end. In the case of an oil engine, space *B* holds air only, which is compressed and used for

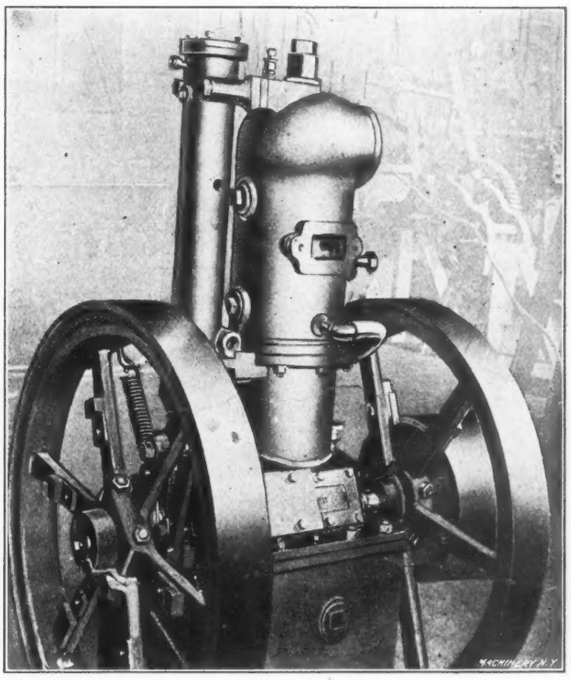


Fig. 1. Newcycle Gas and Oil Engine

injecting the fuel in a blast or spray, while for a gas engine the gas or a rich mixture of gas and air is compressed in this space. When compressed, the charge of air (or gas) enters the valve chest *D* which also acts as a receiver. The admission of air to the annular space *B* is governed by the slide valve *E*, which admits air through the inside port, while the discharge is around the lower edge of valve *E* and up through this valve into the receiver *D*. When the piston is near the end of its downward stroke, it uncovers exhaust port *S* and directly afterward the port *P*, thus releasing the air which has been compressed in the crank-case by the downward motion of the piston. As this air enters, it strikes a baffle-plate *T* on the piston and is deflected upward so that the burned gases are forced downward and out of the exhaust. The volume of the crank-case has been made sufficiently greater than the piston displacement, so that, after allowing for volumetric losses, a charge of air great enough to insure perfect scavenging is injected into the cylinder at the end of each working stroke. The passage of air through the exhaust at this point in the cycle is, of course, immaterial, as the fuel is not as yet mixed with it. Soon after the piston starts on its upward stroke, the valve *F*, which with *E* is actuated by an eccentric, uncovers the port *M* and suddenly releases the air in valve

chest *D*, which then passes through port *M* and the check valve *H*. This is at the time when the exhaust gases have practically all left the cylinder, and when the greater part of the air from the crank-case has passed in through port *P*. The compression begins, of course, as soon as the ports in the side of the cylinder are closed, and the valve *H* automatically seats as soon as the pressure is equalized.

In the case of a liquid fuel engine, the fuel is injected into the passage *M* by a small pump such as is commonly used on kerosene engines. This pump is under the control of a flywheel governor which regulates its stroke and, therefore, the quantity of oil supplied, according to the load on the engine. As the air in chamber *D* is under pressure, its sudden discharge at high velocity through port *M* causes the fuel, which is partly atomized mechanically, to be thoroughly carburetted.

It should be mentioned that the exact construction illustrated is not necessarily to be followed in detail, as modifications will doubtless be necessary to meet different conditions, but the views presented herewith serve to show the cycle of events and the principles involved.

An engine of this type having a 5- by 6-inch cylinder, developed, during a recent test at Cornell University, 6¼ horsepower, running at 360 revolutions per minute, and over 7 horsepower during a short period of the time.

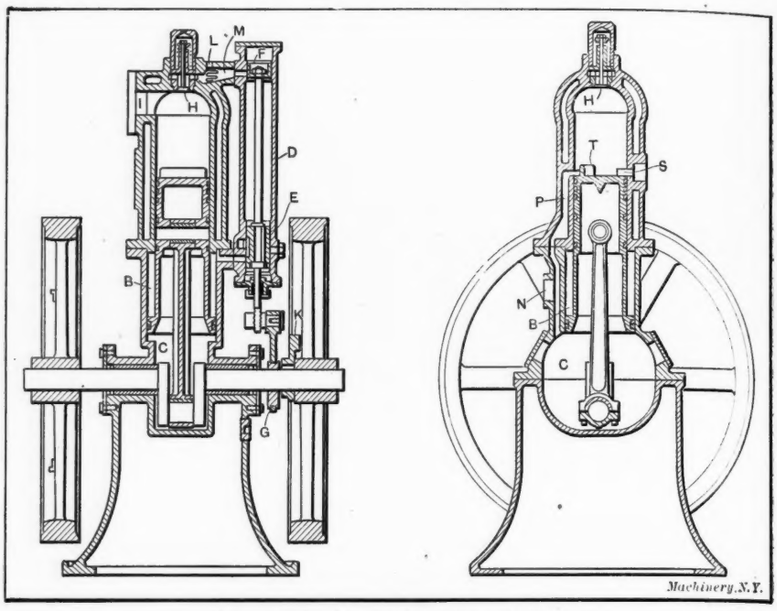
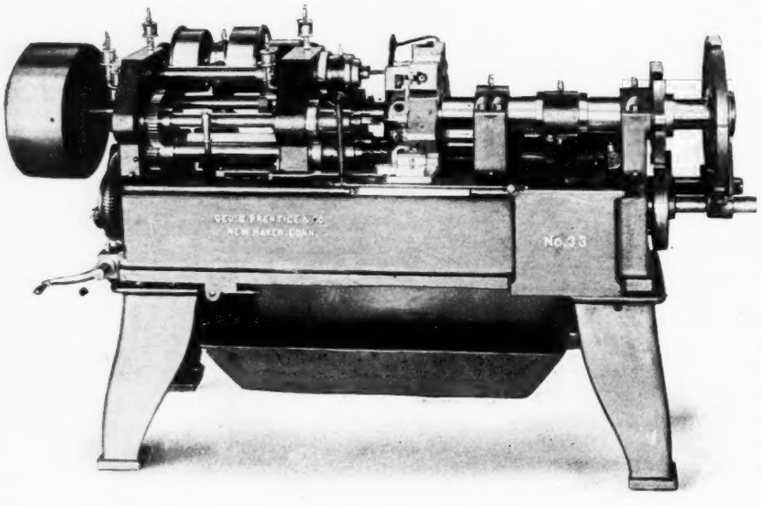


Fig. 2. Sectional Views of the Newcycle Engine

PRENTICE FIVE-SPINDLE AUTOMATIC WITH TWO TAPPING SPINDLES

The multiple-spindle automatic turret machine illustrated herewith is a modification of the standard five-spindle automatic built by George G. Prentice & Co., Inc., New Haven, Conn. This machine is arranged especially for the drilling, tapping, etc., of solid castings, forgings and similar work requiring two taps—one under-size for roughing out and the other for finishing. By this method two light cuts are taken, and the breakage of taps of, say, ⅜ inch or smaller, due to the clogging of chips when using one tap, is overcome.



Prentice Five-spindle Automatic Turret Machine with Two Tapping Spindles

The tapping mechanism consists of a pair of friction pulleys—one for the forward and one for the reverse drive—which are automatically tripped after tapping the required number of threads. The tapping is done by the fourth and fifth spindles, both of which are yoked and geared together and driven by one set of friction pulleys. When starting a new job, the roughing tap is first run through the hole; then the finishing tap is started a few threads by hand into the hole to get the lead. When the collets are tightened, both taps will maintain the same lead.

The machine illustrated has a six-section chuck or work-holder. Five pieces are operated upon simultaneously in this machine while the operator is removing and inserting work at the sixth section of the chuck. The five spindles may be equipped with any arrangement of tooling, including drills, reamers, counterbores, facers, box tools, taps, etc. The machine as shown is equipped with tools and work-holders for drilling, counterboring, and tapping the binder screw holes in automobile clutch-shifter fork forgings.

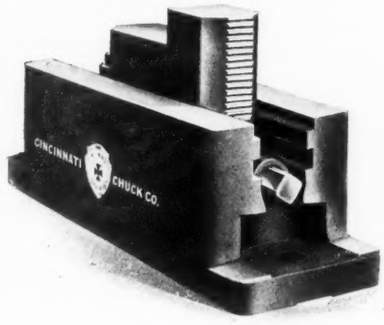
The principle of this machine is the same as in other Prentice single-head automatics. The chuck is automatically advanced towards the revolving spindles by means of a cam on a large drum inside of the bed. There is also a return cam to draw the chuck away from the tools at the completion of the operations. The camming is timed so that the chuck is automatically indexed to the succeeding operation as soon as the longest operation has been completed. A new feature being applied to Prentice automatics, is a differential feed mechanism for speeding up the indexing time of the chuck. By this means the production is increased about 30 per cent.

As all the operations on any piece of work done in this machine are finished complete within the cutting time of the longest operation only, a great saving in time is effected. A further reduction is made on that class of work which requires the drilling of long holes, by drilling one-half the length in one spindle and the remainder in the succeeding spindle. Thus a hole of 2-inch depth could be drilled the entire length, reamed, faced, tapped, etc., in the time that would ordinarily be consumed in drilling a hole one-half that depth. This machine has ample power to drill and tap up to ⅝ inch in diameter, although the class of work requiring the double tapping arrangement is generally ⅜ inch and smaller. The net weight of this machine, with countershaft, is about 3000 pounds.

CINCINNATI FACEPLATE JAW

The Cincinnati Chuck Co., Cincinnati, O., is now manufacturing a new faceplate jaw, which we illustrate herewith. The chief feature of this jaw lies in the method of mounting the screws in hardened steel bushings which provide a full bearing for the trunnions of the screws and receive the end thrust on their hardened circular faces, thus minimizing

wear and resultant end play. In the ordinary faceplate jaw, the screws are mounted in semi-circular bearings and receive the end-thrust on semi-circular shoulders formed in the cast-iron shell of the jaw, which results in excessive wear that is difficult to overcome. The patented bushings with which these new jaws are equipped will, of course, prove more durable, and when end paly does develop, the construction is such that the bushing can be taken out and replaced by any machinist in a very short time, making the jaw, in this respect, just as good as new. These bushings also serve to hold the screws in absolute alignment with the jaw, thus preventing any tilting of the screw and consequent cutting of the thread. These features are of considerable importance, and overcome most of the jaw troubles commonly experienced.



Faceplate Jaw made by the Cincinnati Chuck Co.

TURRET TOOLPOST FOR LODGE & SHIPLEY LATHES

The Lodge & Shipley Machine Tool Co., Cincinnati, O., has recently designed a new turret toolpost which may be applied to any size of lathe manufactured by this company. With this new design, the turret can be indexed to eight different positions so that the tools may be set diagonally, as well as at right angles to or in alignment with the cross-slide. Each tool is clamped well forward of the center so as to give a firm support, and the clamping of the binder lever does not appreciably change the position of the turret.

The lower block of this attachment is interchangeable with the compound rest slide and is fitted to the carriage dovetail by a taper gib. A vertical stud is secured in this base and passes up through the turret to carry the binder lever at its top. The toolpost is of steel. Each one of the four tools rests upon a serrated and hardened bolster or rocker, against which it is held by three hardened cap-screws. By rocking the bolster in its curved seat, adjustment for the height of the tool point can easily be made. When the various cap-screws shown are tightened, the tool is held rigidly in position.

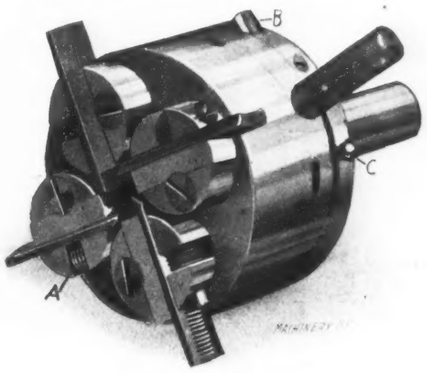
Turret Toolpost which may be indexed to Eight Different Positions

The turret revolves freely on a taper bearing which is concentric with the vertical stud, but does not touch the stud. A bushing, which is tapered to fit the bearing of the turret, is slipped over the stud. An adjusting nut is threaded to the stud and bears against the upper end of the taper bushing; so that by tightening this nut, the bushing can be pushed down to eliminate play in the bearing. The large collar between the binding lever and the turret, covers the end of the taper bushing and its adjusting nut, so that no chips can get into the bearing. As the large diameter of the taper bearing is at the top, the turret is at all times held against the horizontal bearing of the lower block so that when the binder is clamped, the position of the turret and tools remains unchanged.

The turret is exactly located in any one of the eight positions by a locking bolt which engages notches in an index ring. This locking bolt is withdrawn by the handle seen at the front of the lower block. Compensation for wear in the bearing of the locking bolt is provided for by a taper gib. A coil spring holds the locking bolt against the index ring so that it will at once drop into the notch when the proper point is reached. The screw shown in the illustration just beneath the end of the locking bolt provides adjustment for the tension of this coil spring.

BICKFORD AND WASHBURN TAP THREADING DIE

The die shown in the accompanying illustration, which is manufactured by Bickford & Washburn, Inc., Greenfield, Mass., is intended for the threading of small taps. In this die the well-known milled thread chasers have been used. The advantages of these chasers over the hobbed cutter are in the longer life of the chaser and the shearing cut, which produces a smooth thread when cutting tool steel.



Die for Threading Commercial Taps

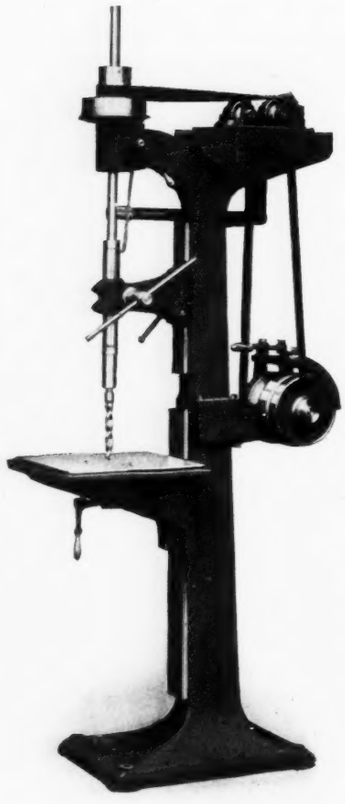
This die, which is designed to be used in a hand screw machine having a lead-screw attachment, has a body 4 inches in diameter, 2¾ inches long, and a shank 1 inch in diameter. The shank is hollow and is tapped for a pipe connection so that when the die is in use, a strong flow of oil from the rear keeps the chips well away from the work. The main body is a solid piece of steel accurately bored to receive the cylinders or chaser holders. It is also recessed at the back to make space for short arms which are let in flush at the back end of the cylinders and project across, thus making a bearing to prevent the forward movement of the cylinders. Any backward movement is prevented by the cam plate which comes up directly against the back of the main body and also against the arms referred to. These arms carry pins which are operated by slots in the cam plate, thus opening and closing the die. A collar of the same outside diameter as the main body, is placed just back of the cam plate, and has in its front side a circular recess, into one end of which projects screw *B* which stops the rotation of the cam plate by means of a stud projecting from the plate back into the recess referred to. By turning screw *B* the closed size of the die is determined. The stud in the cam plate is covered by an eccentric sleeve which is operated by the small knob *C*, thus allowing a thick or thin part to come against the end of the screw *B*, so that, by taking a first cut with the knob *C* in the position shown, a very light finishing cut may be taken.

This is a feature in the construction, which will be appreciated by tap makers, as it enables roughing and finishing cuts to be taken. By turning pin *C* to the proper notch for the first cut, it is possible to vary the amount of the finishing

cut as desired. The chasers are held in position by taper gibs which are tightened by the binding screws shown. The necessary adjustment is obtained by means of short worms *A*, inserted in the holders and engaging with the backs of the chasers which are hobbed to receive them. It is possible with this die-head to thread any size of tap within its capacity with the same set of chasers, the proper cutting size being obtained by means of the graduated adjusting screw *B*, as explained.

KERN HIGH-SPEED SENSITIVE DRILL

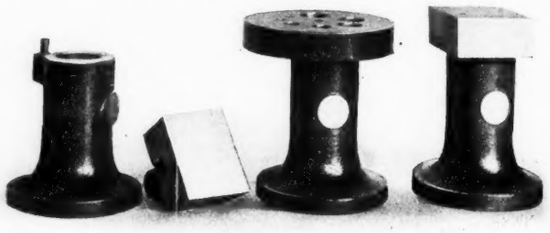
A high-speed, ball-bearing, sensitive drill that is heavily constructed throughout and intended for hard and continuous service, is shown in the accompanying illustration. This machine which is the product of the Kern Machine Tool Co., Cincinnati, O., is exceedingly simple in its design and contains a number of exclusive features. Ball bearings are used throughout, and all cones and ball races are made of steel and are hardened and accurately ground on special machines. The lever at the left of the column near the top controls the idler carriage which is free to move longitudinally. A slight downward pull on this lever loosens the belt and allows speed changes to be instantly made, while an upward movement of the lever tightens the belt to any required tension and automatically locks the idler carriage. The spindle cone, which has two steps, is mounted on a sleeve that is journaled in the column, thus relieving the spindle of any belt pull. This sleeve also serves to raise and lower the cone by means of a rack and pinion operated by the small lever shown on the right side of the column at the top. This vertical adjustment of the spindle cone permits the small or large step to be brought in alignment with the idlers at the rear. Four spindle speeds are available, two being obtained through the two-step cone and the like number by a two-step cone on the countershaft. It will be noted that the belt-shifting lever is conveniently located and also that the idler pulley is somewhat smaller in diameter than the driving pulley in order to relieve the tension on the belt when the machine is not in use. The upper and lower sections of the column are tongued and grooved to prevent any disturbance of the alignment. The spindle is double-splined and the spindle sleeve is graduated and fitted with an adjustable stop collar. The spindle has a traverse of 15 inches and is bored to a No. 2 Morse taper. The distance from the spindle to the face of the column is 8 inches, and the maximum distance to the table is 32 inches. With a countershaft speed of 800 revolutions per minute, spindle speeds ranging from 600 to 1800 revolutions per minute can be obtained. The table of this machine has a traverse of 21 inches and the head 9 inches. This type of drill can be furnished with any number of spindles up to and including six. The net weight of a single spindle machine is 485 pounds.



High-speed Sensitive, Ball-bearing Drill

CASCADE COMBINATION BENCH ANVIL

A combination bench anvil that is the product of the Cascade Tool Co., Cohoes, N. Y., is shown in the accompanying engraving. As this illustration is largely self-explanatory, the usefulness of the tool will be at once apparent to the mechanic. The combination consists of a tubular base or stand and an interchangeable anvil and disk, the latter having a series of holes ranging from ¼ to 1 inch in diameter. The disk has a center hole which engages a pin on the base so that when it is revolved, the holes of various sizes are brought in alignment with the bore of the base for driving arbors, pins, etc. This disk is ground on both sides so that it may be used either side up, and, if desired, one side may be used for rough and

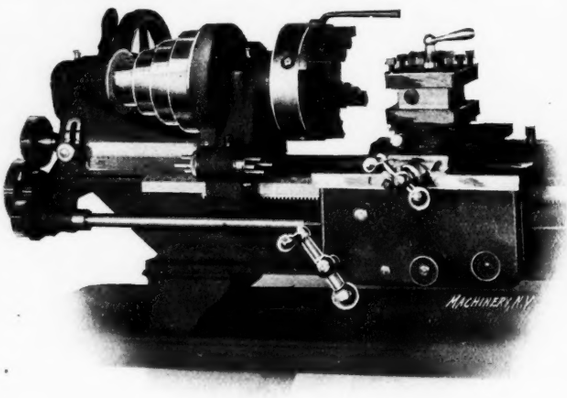


Combination Bench Anvil with Block and Arbor Disk

the other for finished work. When the disk is not required, it may be lifted off and replaced by the square anvil shown, thus making an excellent bench block for hammering, riveting and similar work. The anvil is also ground on the top and sides, and the supporting base is faced true on the top and bottom. This combination anvil, or a tool of similar construction, could undoubtedly be used to advantage in every shop. In many instances much time is needlessly wasted because of the lack of such inexpensive, but nevertheless, useful tools. The price of this anvil complete with interchangeable anvil and disk is $2.50.

ATTACHMENTS FOR "STAR" LATHES

In the accompanying engraving two new attachments are illustrated which are intended for use on the well-known 9- and 11-inch "Star" lathes, manufactured by the Seneca Falls Mfg. Co., 330 Water St., Seneca Falls, N. Y. One of these attachments consists of a combination carriage turret and toolpost, which is mounted on the cross-slide of the lathe in place of the compound rest. This holder has four holes into which



"Star" Lathe equipped with Combination Turret and Toolpost, and Carriage Stop

round-shank tools may be inserted. Binding screws are also provided for holding four regular turning tools. Of course, the tools may be fed either by power, cross or longitudinal feeds, or by hand if desired.

There is shown clamped to the bed in the illustration another attachment which is used to locate the carriage for shoulder distances, etc., when turning duplicate pieces. This stop, which may be attached to the bed at any desired position, has a revolving cylinder containing four adjustable stop-rods which positively locate the carriage. This cylinder may be re-

volved by hand and is held in position by a detent spring and ball.

These two attachments may, of course, be used singly or together. The advantages of the turret are obvious, and the carriage stop will prove valuable for interchangeable work, as it will eliminate measuring each piece, and insure uniform dimensions.

MORTON SPECIAL DRAW-CUT RAILROAD SHAPER

A shaper of the draw-cut type that has been specially constructed to meet the requirements of railway work, is shown in Fig. 1. This machine, which is the product of the Morton Mfg. Co., Muskegon Heights, Mich., is an improved design in which a number of changes have been incorporated to increase its durability, general efficiency and range of usefulness.

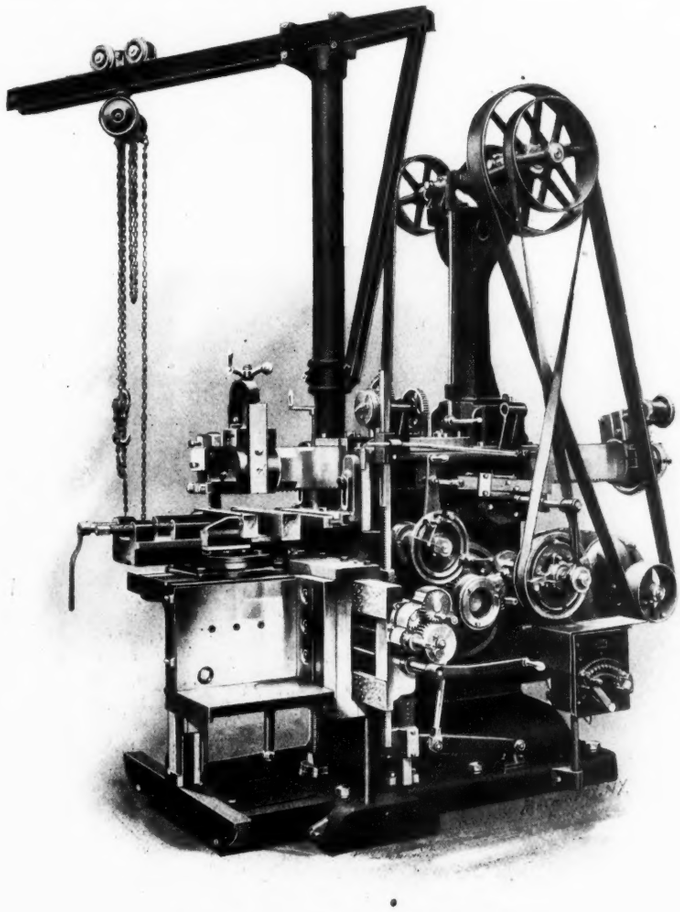


Fig. 1. Morton Special Draw-cut Railroad Shaper

The particular machine illustrated is electrically-driven with a belt transmission which is the form of drive recommended by the makers. As the illustration shows, the motor is mounted on a sliding base at the rear of the column so that the driving belt to the countershaft may be made endless and adjusted for the proper tension. This countershaft has a special friction clutch which may be operated by a conveniently located lever so that the machine may be started or stopped instantly without interfering with the motor. This feature places the machine under complete control of the operator as it enables him to move the ram 1/16 inch at a time, if desired, whenever adjusting or setting the tool. As shown, the drive to the reciprocating clutches is by belts which absorb shocks and tend to protect the motor. The variable speed type of motor with a two or one variation is ordinarily used, but as the cutting speed of this machine is uniform irrespective of the length of the stroke, a constant speed motor may also be used.

The friction clutches, through which, by means of the open and cross belts, the reciprocating motion is given to the ram, are of an entirely new design. The friction surface is made flat, with a revolving disk, which is covered on both sides by vulcanized fiber. The compression is formed by a sliding collar and compression levers provided with set-screws which give ample compensation for wear. The flat disks may be relined at small expense, and being lined with fiber, they never injure the metallic surfaces of the clutches. The reversing mechanism for operating the clutches is also of new design.

The stroke of the ram is adjusted by tappets mounted on a circular disk. Adjustments can be made while the machine is in motion, and the movement of the ram can be reversed by a lever at the will of the operator. The ram has a quick return of 2½ to 1, at a uniform speed.

The friction feed of this machine is of the automatic relieving type, and gives any feed ranging from 1/32 to ⅝ inch, horizontally, and 1/32 to 5/16 inch, vertically. Variations are obtained by moving tappets on a circular disk, which is graduated with suitable index stops.

A power traverse for raising and lowering the cross-rail and moving the apron sideways is supplied. These movements are controlled by a lever which when shifted in different directions moves the apron either to the right or left. As only thirty seconds is required to move the apron the full width of the cross-rail, and forty seconds, for raising or lowering the cross-rail, this feature effects a considerable saving in time when making adjustments.

The ram of this shaper is provided with a rotating arbor, which may be fed automatically in either direction for planing curved surfaces. The rotary-feed motion is transmitted to this arbor from the regular friction, through a gear and ratchet working in conjunction with a vertical bar, connected to a splined shaft, which, in turn, transmits the movement to the arbor. The mechanism is clearly shown in the engraving.

The column of this shaper is of the box type and heavily constructed. All shaft journals, which are mounted in the column, are run in bearings which are fitted in accurately bored holes, thus insuring perfect alignment and rigidity. The knee is of a special design, of the angular bracket type that is adjustable vertically on the saddle, so that the distance between the ram and the table may be increased. The table is held in position by a tongue which fits a slot in the knee, and by four bolts, so that it may be quickly removed or placed in position. The vise is of the swivel type and is graduated in degrees. An adjustable back-bearing forms a stop against which work may be placed while being held in the vise or otherwise. This bearing transfers the thrust of the cut directly against the column so that it is not necessary to clamp the part being machined so firmly.

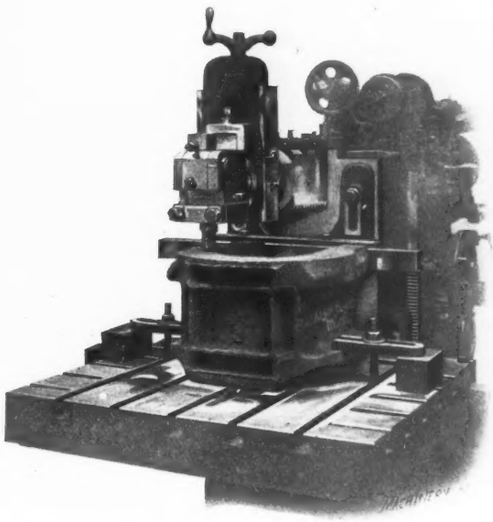


Fig. 2. Planing the Sides of a Driving Box

As in previous designs, a crane and hoist is directly attached to the machine, which greatly facilitates the handling of heavy parts. Ordinarily a two-speed hoist of one ton capacity is furnished, that is so arranged that when lifting one-third load, it operates directly and with twice the speed. If desired, the makers are prepared to furnish an air hoist in place of the chain type. This crane will cover a floor space 12 feet in diameter, and the maximum distance from the floor to the hoist is 7 feet.

In order to illustrate the adaptability of this tool to railway work, a number of illustrations showing the machine set up for planing a locomotive driving box and its brass are given. Fig. 2 shows the way the sides of a driving box are planed. As the work is placed against the back-bearing previously referred to, the thrust of the cut is taken directly against the column so that the two small clamps shown are sufficient to hold it in position. For planing the crown brass seat, a double chuck, such

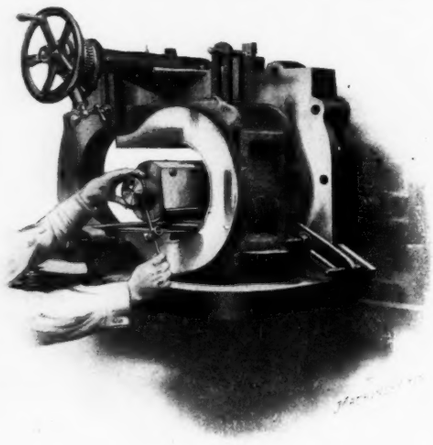


Fig. 3. Gage used in Conjunction with the Ram for Setting Boxes

as is shown in Fig. 3 is used, which has a capacity for two boxes. This chuck is secured to the knee or bracket table of the shaper and it is provided with a back-bearing which transfers the cutting strains to the column. A bracketed bearing is attached at the top which extends forward, thus bringing the operating handwheel in a convenient position. The handwheel is connected to the arbor-rotating mechanism by a universal shaft so that the rotating head may be turned by hand in either direction. Fig. 3 also shows a gage that is used for set-

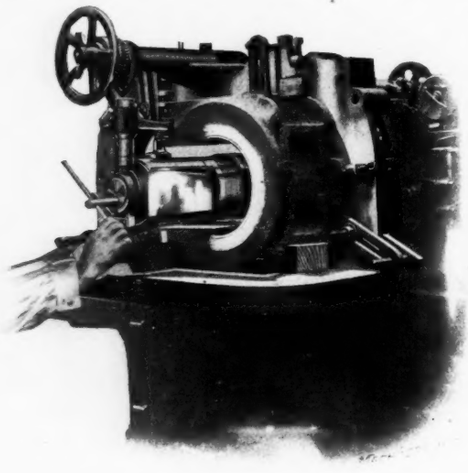


Fig. 4. Setting the Tool by Special Micrometer Gage

ting the box prior to planing. This gage, to which may be attached the scriber of an ordinary surface gage, is accurately fitted to an extension on the rotating head; the extension is also used for holding the micrometer attachment illustrated in Fig. 4, which is used for setting the tool to a given radius. This attachment consists of an arm long enough to meet all requirements, on which there is a scale that enables a sliding bracket to be quickly set to the desired radius. By means of a micrometer screw against which the point of the tool is set, as shown, allowance may be made for the roughing and finishing cuts. After the tool is placed in the proper holder and inserted in its slot from the top, the micrometer

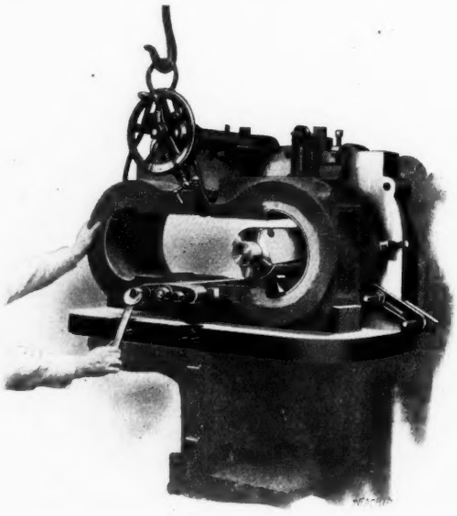


Fig. 5. Placing a Second Box in Position while Planing the First

attachment is placed in position and the tool is raised up to the adjusting screw which has been set inward for the roughing cut. When the tool is being set for a finishing cut, the micrometer screw must be up to the shoulder stop.

The advantage of the double-chuck arrangement is shown in Fig. 5, which illustrates a second box being placed in position while the first is being machined. Obviously the oil cellar fittings may be machined at this same setting of the work if

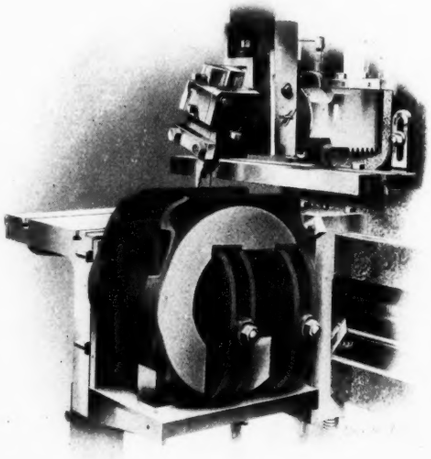


Fig. 6. Method of Holding the Box while Planing Shoe and Wedge Fits

desired. After the crown brass has been forced into the box, it can also be planed for the journal fitting. In Fig. 6, the box is shown in position for planing the shoe or wedge fittings. In cases where single boxes are being finished or when they are being replaned, this machine would undoubtedly handle the work in a very satisfactory manner.

An interesting set of transfer gages for use when fitting the crown brass is shown in Fig. 7. The inner gage, shown applied to the box at the right of the illustration, is so designed that by one or two simple adjustments, the shoes on either side are set to the undercut angles and a central point is brought to bear against the crown so that there are three points for measuring which project beyond the box face. The outer or crescent-shaped gage is next set by these projecting points and then applied to the brass as shown, after the latter is planed on the outside. By means of a scriber, lines are drawn on the end of the brass, thus enabling it to be accurately fitted

to the box. These lines may be quickly and easily set in a vertical position for planing, by means of a special gage.

The attachment for planing the brasses is shown in Fig. 8. This attachment has a tongue fitting a slot in the table so that it is self-aligning. The head is provided with adjusting screws, as shown, which bear against the machine column. The chuck for holding the brass is so constructed that the work may be gripped in any desired position by means of one bolt,

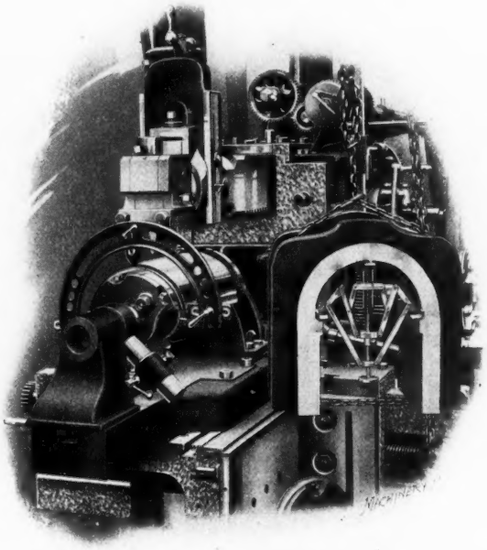


Fig. 7. Inside and Outside Transfer Gages for Crown Brass Work

and as the front head is adjustable, various lengths may be held. The rotary feed is obtained through a worm-gear and flexible shaft which is connected with the regular feed mechanism so that when the ram reciprocates, the chuck is made to revolve intermittently. Fig. 8 also illustrates the use of the micrometer attachment, which is used to scribe a line on the brass at the desired radius. Obviously this line is not broken out by the tool, as the latter begins its cut at this end; this enables the workman to split the line and to produce accurate

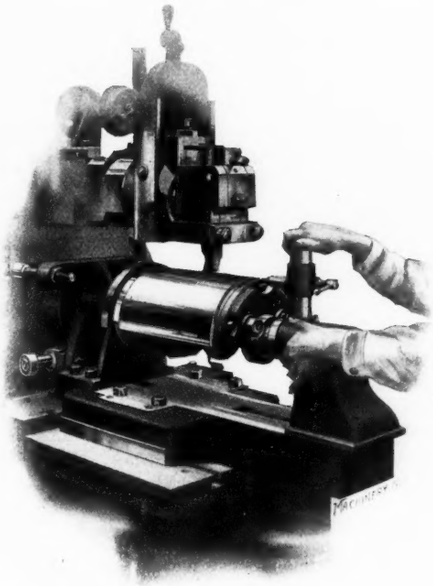


Fig. 8. Use of Micrometer Gage for Sizing Crown Brass

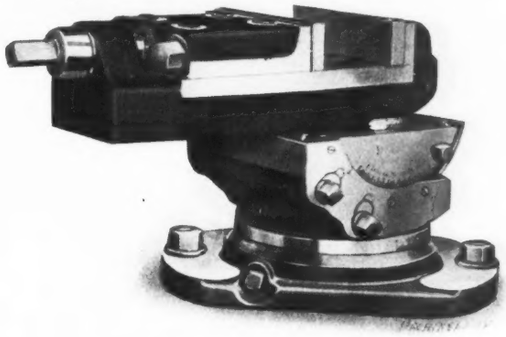
results. The draw-cut also throws the chips away from the operator rather than toward him.

This shaper has a working stroke of 32 inches, a horizontal table feed of 36 inches, and a vertical table feed of 18 inches. The approximate net weight is 10,000 pounds to which 2500 pounds are added when the machine is equipped with a motor drive.

AETNA THREE-WAY VISE

An interesting and useful tool of universal application on the milling machine is illustrated in the accompanying half-tone illustration. This device, known as the Aetna three-way vise, is built by the Becker Milling Machine Co., Hyde Park, Mass., and while especially adapted for use with the Becker milling machine, it can be employed, of course, to advantage on milling machines of any type. The vise is provided with adjustments in three planes, so that it can be set practically to any position imaginable within the range of its size. Each of the three adjustments is entirely independent of the others and the respective angles are read in degrees directly from engine-divided dials.

The first adjustment is in a horizontal plane about a vertical axis. This adjustment permits of rotating the work around a full circle, or through 360 degrees. The second movement is at right angles to the plane of the first, and permits of adjustment from the horizontal to the vertical plane through an arc of 90 degrees. The third adjustment, again, is at right angles to the plane of the second, whatever that may be in any one case. The ultimate position of the adjustment of the third swivel which holds the vise proper, depends upon the adjustment of the two previously mentioned. The work can be rotated by this adjustment through an arc of 360 degrees. Although in this manner three joints are introduced from the base to the vise in order to make the device universally adjustable, the tool is so designed as to insure a rigid construction, and is firmly secured to the milling machine table by two bolts. The work to be milled can be clamped in any position



Aetna Three-way Vise for Milling Machines

without disturbing these bolts. The jaws of the vise proper are steel faced.

The capacity of the vise illustrated is as follows: The jaws will open to a maximum width of 3½ inches; the depth of the jaws is 1½ inch, and the width of the vise jaw surface is 5 inches.

WILEY AND RUSSELL THREADING, TAPPING AND CUTTING-OFF MACHINE

A combined bolt cutter, nut tapper, pipe threader, and cutting-off machine, that is especially adapted for railway shops, is shown in Figs. 1 and 2. The headstock of this machine is fitted with a three-step cone pulley and back-gears, through which a special design of work-holding chuck is driven. This chuck has interlocking and interchangeable jaws and is so constructed that it will hold either round or square stock. As the jaws are interchangeable, new ones can be supplied, thus making it unnecessary to secure an entirely new chuck. The spindle is hollow, so that any length of pipe or bolt can be handled. On the carriage, which is operated by means of a rack and pilot wheel, frames for the die-heads are mounted. These frames are connected by a double-threaded shaft so that the dies may be easily opened or closed by means of a handwheel in the front of the machine. Each die-head is accurately fitted in its support and it is held in place by a set-screw that bears against a V-shaped slot, so that the tightening of the screw draws the head against the carrier face. A spring-pin that drops into an opening, prevents the die-heads from turning when the dies are in their proper position. By loosening the set-screw and pulling back the spring-pin, the heads can be

revolved so that any size die within their capacity can be quickly brought into working position. The heads are marked at the top with the size die which is in position for cutting. Each pair of dies has independent stop pins which control its cut. These pins, which are plainly shown in the illustration, can be shortened or lengthened as desired to give the proper diameter of thread. They are made of the very best steel, and are carefully fitted into the circular die-heads. The dies are made in pairs, each of which is properly marked, so that it is a very simple matter to replace them.

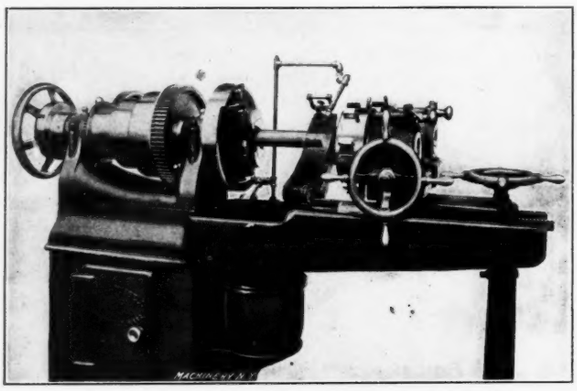


Fig. 1. Combined Bolt Cutter, Nut Tapper, Pipe Threader and Cutting-off Machine

When using this machine for nut tapping, it is only necessary to clamp the tap in the chuck and place the nut in the jaws provided between the carriers that support the die-heads, as shown in Fig. 2. The carriage is then brought up the same as when threading a bolt. It is not necessary to remove the die-heads in order to tap nuts.

A cutting-off attachment, which is plainly shown in Fig. 1, is applied so that it can be swung back out of the way when not in use. This attachment consists of a small carriage with a toolpost and a hand-operated cross-feed. The machine is also provided with a centrifugal oil pump. The lubricant is drained through a screen into a tank below the bed from which it is again pumped to the cutters.

The following figures which relate to the performance of the No. 1 machine, which we illustrate herewith, will serve to

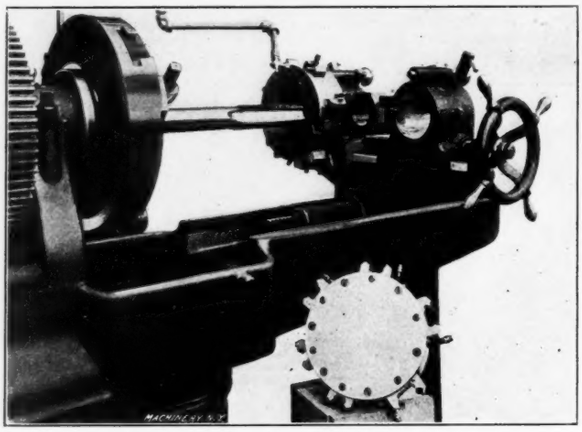


Fig. 2. Machine as used for Nut Tapping

show the possibilities of this type of tool as to output. The threading of ten bolts of the following sizes, ¼, 5/16, ⅜, 7/16, ½, 9/16, ⅝, ¾, ⅞ and 1 inch, was accomplished in ten minutes. The same machine also cut a thread 6½ inches long on a 1-inch bolt in one minute from the time the workman picked up the stock until the finished bolt was removed from the machine. Ten one-inch bolts were threaded for a distance of 1⅞ inch, in six minutes, thirty seconds, and threads were cut on eight steel pipes ranging in size from ¼ to 2 inches, in fifteen minutes, a little over a minute being required to replace the bolt-cutting die-heads with those for pipe threading.

For roundhouse work this machine offers many advantages. It is also well adapted to the work of the erecting shop, where it is often necessary to quickly thread bolts or to chase a thread that has been damaged. With three sets of die-heads, the machine is equipped for threading practically all sizes of bolts from ¼ to 2 inches, as well as piping between the same dimensions. This machine is rigid in its design and wherever miscellaneous threading is to be done, it will undoubtedly prove very efficient. It is the product of the Wiley & Russell Mfg. Co., Greenfield, Mass.

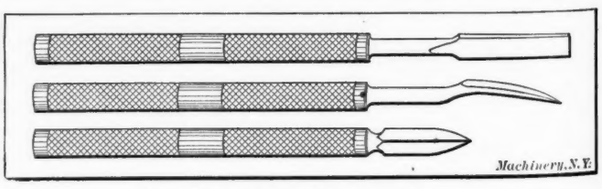
HAUCK KEROSENE BLOW TORCH

A blow torch in which kerosene is used as a fuel instead of gasoline is shown in the accompanying illustration, being used for brazing cup joints. This torch is said to give better results with kerosene than can be obtained with gasoline. It is adaptable for various heating operations, such as light brazing, tinning, etc. The flame produced is intense and clear, and the construction is such that the tank will remain perfectly cool while the burner is being operated. Only one-pound air pressure is required on the torch, which is obtained by a hand-pump in the usual manner. The flame of this torch will melt a piece of copper ½ by ¼ inch, in three minutes and a 1-inch brass rod in two minutes. The particular torch illustrated has a capacity of ½ gallon, and the consumption per hour is 2½ pints. Larger sizes, however, may be obtained, if desired. The cheapness of kerosene and its comparative safety is, of course, a commendable feature. These torches are simple in design and strongly built to withstand rough usage. They are made by the Hauck Mfg. Co., 140 Cedar Street, New York City.

Kerosene Blow Torch being used for Brazing

TOOLMAKERS' SCRAPERS

The scrapers shown in the accompanying engraving are intended for the use of toolmakers or other mechanics who desire something neater and better than a three-cornered or half-round file for scraping. These tools will be found useful in connection with vise work, metal patternmaking, and for similar work. The handles are made of steel tubing and the cutting points of the finest grade of tool steel, which is properly tempered, ground and polished. These scrapers are made in a number of styles, only three of which are shown in the engraving. The upper tool is a small, flat scraper which may be obtained in different widths; the second is of the half-

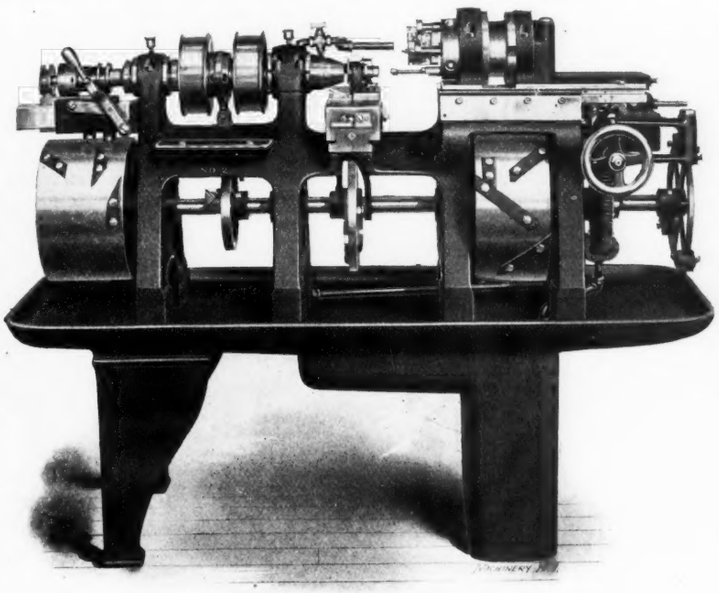


J. E. Poorman Co.'s Scrapers

round, curved type for use in small bearings, etc., while the lower one has a triangular blade which is hollow ground on the sides. These tools are the product of the J. E. Poorman Co., Inc., Bradbury Building, Philadelphia, Pa.

NATIONAL SEWING MACHINE CO.'S AUTOMATIC SCREW MACHINE

The single-spindle automatic screw machine which we illustrate herewith, has been placed on the market by the National Sewing Machine Co., Belvidere, Ill. The distinctive features claimed for the general construction of this machine



National Sewing Machine Co.'s Automatic Screw Machine

are: convenience of operation, simplicity in the changing of cams, ease with which adjustments may be made for various classes of work, and low maintenance expense.

The spindle of the machine is driven by a quick-acting friction clutch which is positive and instantaneous in its reverse motion, permitting uniform lengths of thread to be cut when threading. This clutch is operated by a small disk-cam mounted beneath the pulleys on the drum-cam shaft. The stock is fed through the spindle, and the chuck is operated by the drum-cam at the left end of the shaft. Provision is also made for operating the chuck by hand in case this is necessary when setting up the machine.

The turret, it will be noticed, is 'n a horizontal position, rotation being about a horizontal axis. The location of the locking bolt, which is quick and positive in its action, is such that it engages the turret on a larger radius than that occupied by the tools, which tends to maintain the latter in alignment with the spindle, thus insuring accuracy of the output. The turret is fed to and from the work by a drum-cam.

An accelerated movement for the drum-cam shaft and turret-slide, is obtained through a positive clutch when the tools are not in use, so that they recede from and advance to the work at comparatively high speeds. When the tools are in action, the slower feed then required is obtained through a differential planetary gear system, which reduces the movement between the driving pulley and worm-shaft in the ratio of 48 to 1. The spider disk on the right end of the cam-shaft, controls, by means of dogs on its periphery, the engagement and disengagement of the clutch and consequently the rate of feed. These changes are made instantaneously.

The cross-slide is operated independently to a stop which gives uniform sizes in forming operations. The movement of this slide is controlled by the disk-cam shown beneath it, which engages with the feeding levers shown. These machines are built in two styles, either having a turret or being made plain. The construction of the turret machines is such as to permit the use of taper attachments for turning taper pins and similar work. They are also adapted for thread rolling, knurling, side drilling, slotting and second operation magazine work. The chuck capacity of the No. 2 machine, which is shown in the illustration, is $\frac{5}{8}$ inch. The milling length is $3\frac{3}{4}$ inches and the length of feed is $7\frac{1}{4}$ inches. The spindle pulleys are 7 inches in diameter with $1\frac{1}{2}$-inch width of face. The floor space required for this machine is 3 feet by 4 feet 9 inches.

ELECTRIC HOIST FOR MONO-RAIL SYSTEM

An electric hoist, equipped with two hook-blocks that operate together and are driven by the same motor, is illustrated herewith. This type of hoist is undoubtedly superior to the single hook-block hoist for handling a great variety of work, as the two hooks make it possible to carry a lengthy part straight and level and without the swaying incident to the use of a single hook. This feature permits the making of the runway supports narrow and a wide operating space is not required in the storage room or shop. In handling heavy or bulky material, either one or both hooks can be used and either hook has a lifting capacity equal to that of the hoist.

This hoist is furnished with a seat, as shown, or with a cage if desired. When a seat is used, the operator attaches the work, thus making a helper unnecessary. This hoist is

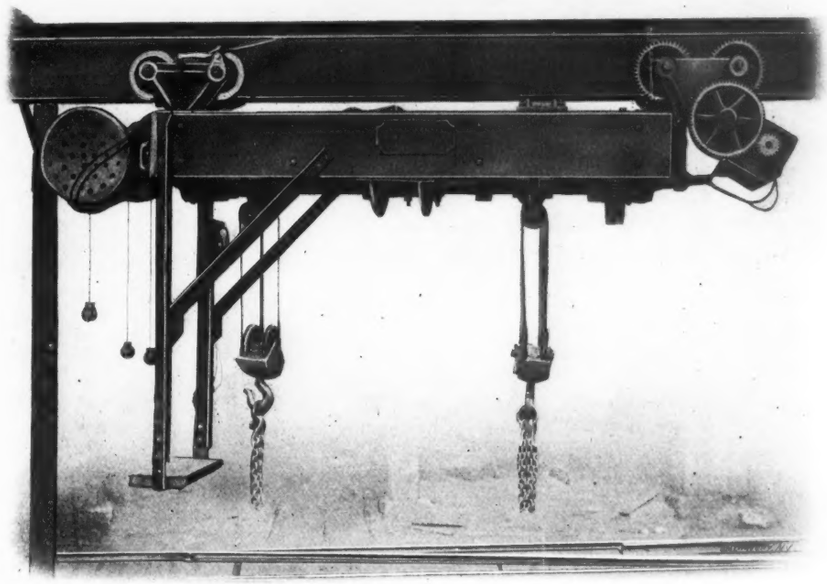


Fig. 1. Electric Hoist with Two Hook-blocks which operate simultaneously

very rigidly constructed throughout. The truck-wheel frames, which are made of steel castings, are interlocked with the main frame and made to swivel when rounding a curve. By means of handled ropes which hang near the operator's seat, all movements are controlled. The hoist is provided with an automatic load or mechanical brake for lowering, that is entirely enclosed and operates in a bath of oil; there is also an

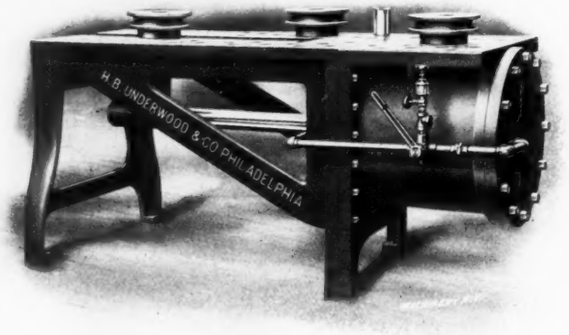
electric brake on the motor. The motor is of the enclosed type, commonly used for crane service. Electric connection to the motor is made by a trolley which is in contact with a conductor attached to one side of the rail as shown. The winding drums have a diameter equal to thirty times that of

Fig. 2. View showing the Electric Hoist and Runway

the rope. The gearing used is of cast steel and the teeth are all cut. All the bearings are bushed with bronze. These hoists are made by the Johnston & Jennings Co., Cleveland, O., in two-, four-, and six-ton capacities.

UNDERWOOD PIPE BENDER

The pipe bender shown in the accompanying illustration, besides being efficient for the bending of pipes, may also be used as a power bender and bulldozer. This tool has a stroke



Machine for Power Bending built by H. B Underwood & Co.

of 15 inches, and the control is very flexible. The work-table is rectangular and is provided with numerous holes for the convenient location of dies or pins. As the top of the table is perfectly flat, it offers no obstruction that will in any way interfere with the work. Innumerable shapes can be bent without the necessity of having a large number of dies, by simply changing the position of the resistance studs. The ram, which is beneath the table, slides in a strongly constructed guide and has projecting above the table a stud on which a roller of suitable size may be placed. Either steam or compressed air may be used to operate the machine. For the former a metallic packing is used on the piston rod and for the latter a leather packing. The use of compressed air is recommended, when available, as it offers many advantages over steam. The cylinder is 20 inches in diameter, and the power of the machine is limited only by the pressure applied to the piston. This piston has air on both sides of it at all times, connection from one side to the other being made by the pipe shown, which connects with the operating valve. This valve is so constructed that only the amount of air required for the actual bending escapes. The air is transferred from one side of the piston to the other, depending on the direction of movement desired. Owing to the unequal areas on the two sides of the piston by reason of the space occupied by the piston rods, the piston is given a sensitive control and it may be moved when necessary only a fraction of an inch. The ram may also be held perfectly stationary to allow measuring or the placing of templets on the work. Such nicety of control is, of course, very desirable, and is particularly useful for straightening work. This machine is manufactured by H. B. Underwood & Co., 1025 Hamilton St., Philadelphia, Pa.

WILLIAMSON PORTABLE GRINDER

A self-contained, motor-driven grinder, which is portable and can be used for grinding inserted-tooth face milling cutters on either a horizontal or vertical milling machine without removing the cutter from the spindle, is illustrated herewith. Mr. H. C. Williamson of the H. C. Williamson Engineering Co., Industrial Building, Indianapolis, Ind., has perfected and applied for a patent on this device.

The machine is shown in Fig. 1 in the position in which it would be used for grinding an inserted tooth cutter on a horizontal spindle. The motor, which is specially designed and

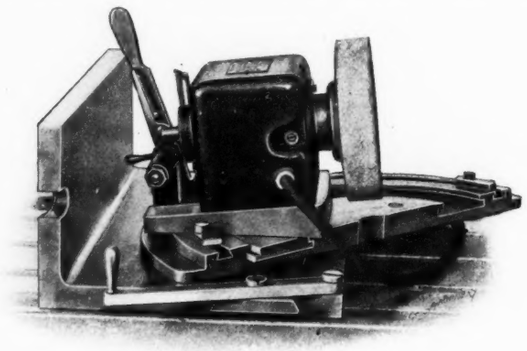


Fig. 1. Williamson Electrically-driven Portable Grinder

may be driven from an electric lighting circuit, is provided with adjustable bearings. It drives a 6-inch cup-wheel and is mounted on a plate having a fixed angle of 5 or 7 degrees, as may be desired, which gives the teeth the proper clearance. This plate is attached to a slide which travels in the circular T-slot of the base shown. The distance of the travel is governed by two stops, which are inserted in an outer dovetailed

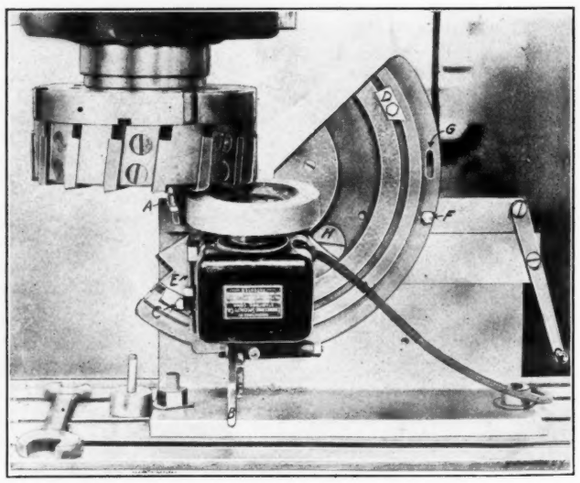


Fig. 2. Wheel in Position for Grinding Ends of Teeth

slot. This circular base is fastened to a slide which can be moved forward or back in the angle plate by the lever shown attached to it. Movements in the opposite directions are obtained by the lever shown pivoted near the back end of the wheel spindle. This lever is used for feeding the wheel up to a tooth for grinding, and its movement is controlled by a positive stop so that each tooth may be ground absolutely the same.

Fig. 2 shows the grinder set up in position for grinding a

10-inch cutter on a vertical milling machine. When the tooth is indexed against finger *A*, the wheel is brought up in contact by lever *B*. By means of the adjusting screw *E*, which comes against a stop, as shown, and controls the movement of the wheel, an equal amount is ground from all the teeth. The stop *C* controls the angular position of the wheel in one direction when grinding the bottom of the cutter. By swinging the motor and wheel around until contact is made with stop *D* (as shown in Fig. 3) the complete cutting edge of the tooth is ground at one sweep. The adjusting screw *E* can be set up so as to give any desired radius for the corners of the

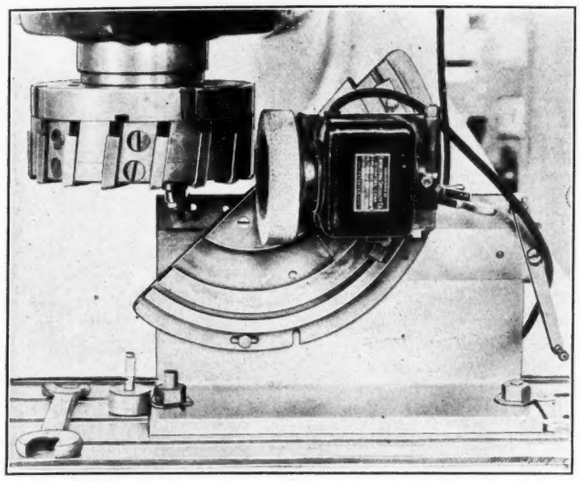


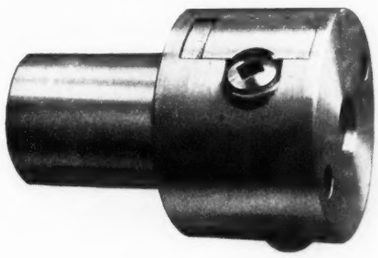
Fig. 3. Wheel swung around for Grinding Sides of Teeth

teeth, from practically a sharp corner to ½ inch radius or larger. The semi-circular base on which the motor and wheel are mounted, swivels on the stud *H* so that its position may be changed for grinding right- or left-hand cutters. This base is secured to the angle-plate by bolts inserted in the slots *F* or *G*, one set being for right-hand and the other for left-hand cutters.

As the illustrations indicate, it is an easy matter for a workman to set up this machine for either horizontal or vertical grinding, and when a cutter is ground while in place, every tooth will run true and do its share of the cutting. This same device can be used in connection with a stand or column so that cutters may be removed and sharpened if desired, and there is no limit to the diameter of the cutter which may be ground.

PRATT TURRET LATHE CHUCK

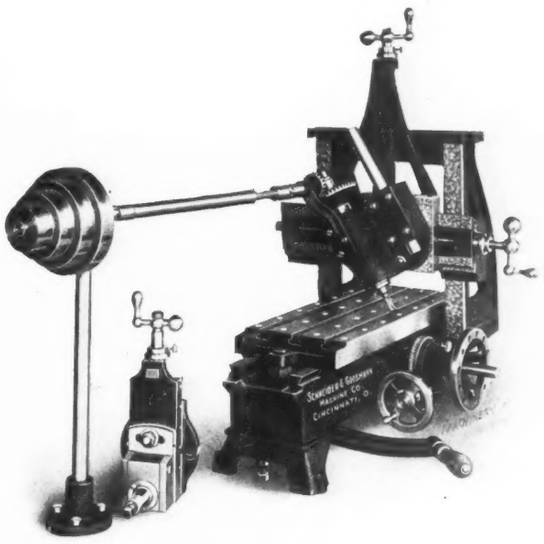
A chuck that has been designed especially for use in turret lathes, turret heads of screw machines, etc., for holding such tools as reamers, drills, outside finishing tools, etc., is now being manufactured by the Pratt Chuck Co., Frankfort, N. Y. This chuck is equipped with the company's patented equalizing driver, which gives a positive rotation to the tool, independently of the chuck jaws. This positive driver is self-adjusting, permitting the jaws to center and align the tool shank accurately in the chuck, so that it is true and at the same time positively held. On finishing cuts, the jaws of the chuck can be partially tightened, thus permitting the tool to float, as the equalizing driver will prevent it from turning and allow it to assume a position in line with the spindle of the machine, thus insuring uniformity of product. These chucks are made in sizes ranging from 2¼ to 6¾ inches in diameter and with drill capacities from ½ to 2 inches.



Turret Lathe Chuck with Positive Equalizing Driver

SCHNEIDER & GOOSMANN HAND PLANER MILLING ATTACHMENT

The Schneider & Goosmann Machine Co., 20 E. 9th St., Cincinnati, Ohio, has designed a power-driven milling attachment that is intended to be used in conjunction with a small hand bench planer which the company manufactures. This attachment is particularly adapted for handling the numerous small milling jobs that come up in the toolroom and in experimental die, jig and similar work. It is attached to the planer saddle in place of the regular tool-slide, and is driven by a cone pulley mounted on an independent stand fastened to the bench as shown. This cone pulley is connected to the spindle of the attachment by a universally jointed shaft and bevel gears. These gears give a 2 to 1 reduction in order that the spindle will be driven with ample power, though gears with a 1 to 1 ratio can be furnished for high speed or light milling operations. The spindle has a taper bearing, and is provided with compensating collars to take up wear. There is a No. 7 Brown & Sharpe taper hole in the spindle, and a draw-in rod for tightening the cutter arbor. The table feed for milling is through a worm and worm-gearing, allowing micrometer adjustment. Micrometer dials are also provided on the cross and vertical feeds. The worm or feed box can be easily attached to the side of the planer bed with very little fitting. Once attached it can remain there, and may be engaged or disengaged by the in or out movement of a pin which fits in any one of a series of holes in the side of the worm-wheel, thus making it possible to quickly traverse the table in either direction. This milling head is very quickly applied to the planer, and it has a wide range of usefulness in addition to ordinary horizontal and vertical milling operations, as the



Schneider & Goosmann 10-inch Hand Bench Planer with Power-driven Milling Attachment

swiveling head allows the cutter to be set to any angle.

The planer itself, which was described in the department of New Machinery and Tools of December, 1909, has a width of 10 inches between the housings and a maximum distance under the cross-rail of 8½ inches. The table is reciprocated, when the machine is being used for planing, by a small handwheel which is mounted directly on the driving shaft which, in turn, is connected with the table rack by a steel pinion. This handwheel, as the illustration shows, has a series of holes drilled in its rim to receive a pin located in the arm of the driving crank. This feature allows the crank to be used in whatever position is most convenient to the operator.

MODERN 20-INCH DRILL PRESS

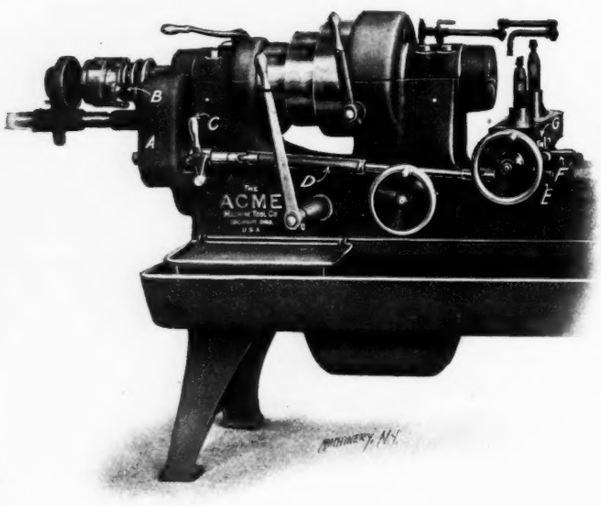
The 20-inch drill press which we illustrate herewith, is built by the Frontier Iron Works, Letchworth and Grant Sts., Buffalo, N. Y., and is designed along the same general lines as the 21-inch machine of the tilting-table type built by this company. The frame of the drill is heavily constructed and the bearings are lined with a special alloy to withstand hard usage

under all conditions. The spindle is of high-grade steel, and it is bored for a No. 3 Morse taper. The teeth of the bevel gears are cut by the generating process, and the gears are practically noiseless in operation. A steel elevating screw is provided for the knee that is operated by a handle connected to it with bevel gears. The machine as illustrated, is equipped with a lever feed and ratchet mechanism which permits the lever to be shifted to the most convenient position. There is also a quick return for the rapid adjustment of the spindle. If desired, a wheel feed can also be furnished at slight additional cost. A treadle form of belt shifter is attached to the base and provides convenient means for starting and stopping the machine. The height of this drill is 62 inches, and the floor space required, 42 by 15 inches. The table has a traverse of 15¾ inches and the spindle, 7½ inches. The diameter of the table is 15¼ inches and the diameter of the column 5 inches. The shipping weight is 650 pounds, to which 100 additional pounds are added when the machine is boxed.

Twenty-inch Drill Press built by the Frontier Iron Works

CROSS-SLIDE POWER FEED OF THE ACME SCREW MACHINE

The power feeding mechanism for the cross-slide of the turret lathe or screw machine manufactured by the Acme Machine Tool Co., Cincinnati, Ohio, is illustrated herewith. The feed changing mechanism, which is of the slip key type, is located in the bracket *A*, which is bolted to the end of the head, suitable holes being provided in all machines for this purpose. Three rates of feed may be obtained by the movement of lever *C*, which has attached to it an index showing plainly the rate of feed being used. The motion is transmitted from the feed-change box to the carriage by a universal shaft which drives a worm located in worm-box *E*. This worm engages with a worm-wheel on the cross-slide screw. The feed is thrown in or out by the lever *F* which may be operated by hand or automatically by dogs *G*, the latter being set to trip the feed as required. This power feed is found very useful for facing large castings, forgings, etc., and work of a similar nature, and it is also used in connection with the cutting-off tool. When so ordered, it can be made with a very fine feed, which is suitable for forming operations and similar work.



View showing Power Feed Mechanism for Cross-slide of Acme Screw Machine

BARNES 15-INCH DRILL

The W. F. & John Barnes Co., 231 Ruby St., Rockford, Ill., has brought out a new drill, intended for light and medium work and particularly adapted for tapping operations. The lever, by which the tapping attachment is controlled, is located just in front of the spindle in a position that enables the operator to reverse the tap without releasing his hand from the feeding wheel, thus making the control as convenient as possible. This lever also serves to start and stop the spindle instantly while the machine is in motion, without shock or jar. The reversals are obtained through a clutch, mounted on the spindle between two bevel gears, which revolve in opposite directions. When the clutch is shifted and engaged with the upper of these gears, the reverse movement is obtained. The tapping attachment may be disengaged by the movement of a lever, so that the gearing of the attachment is only running while it is in use, thus reducing the wear. The wheel for the hand-feed is provided with holes in its periphery, so that the operator has a choice between a lever or wheel feed. This machine is equipped with extra long bearings, solid steel forged gearing for both the bevel and spur gears and hardened steel clutches, all of which insure strength and endurance. The particular drill illustrated has a 15-inch swing, but the geared tapping attachment can be furnished on the 22, 22½, 25, 26, 28, 34, 42 and 50-inch drills manufactured by this firm. The height of this machine is 65 inches and the distance from the spindle to the base 47 inches. The spindle has a travel of 7 inches and is bored for a No. 2 Morse taper. The maximum distance from the spindle to the table is 31 inches, and the table has a working surface of 10 by 12 inches. The floor space required for this tool is 20 by 31 inches and the weight is 290 pounds.

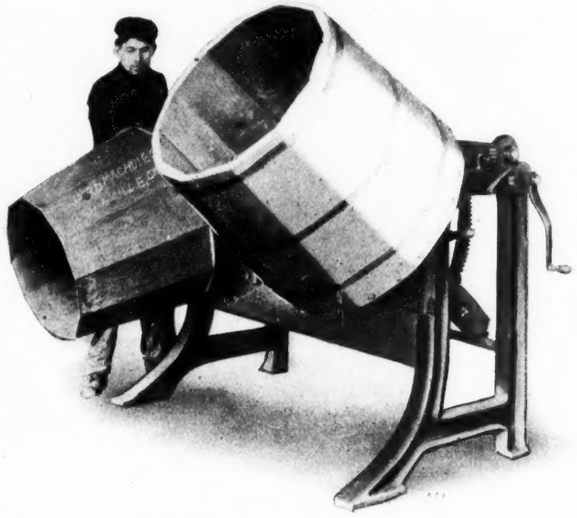
Barnes Fifteen-inch Drill with Geared Tapping Attachment

BAIRD DOUBLE OBLIQUE TILTING TUMBLER

In the May number of MACHINERY, in the department of New Machinery and Tools, we illustrated and described a large tilting tumbler which is a product of the Baird Machine Co., Oakville, Conn. This firm has now brought out a new tumbler of the duplex type which we illustrate herewith. This machine, which with others of its class, is used largely for the polishing and grinding of various articles, has been designed particularly for concerns which have considerable work of this kind, and which have heretofore found it necessary to employ

a number of single and independently-driven units. This tumbler, as is evident from the illustration, takes up less room than two single machines, and it has the additional advantage of being driven by a single belt. The movements of the barrels, however, are entirely independent, so that one can be emptied and refilled while the other is in motion.

The driving pulley is located between the two barrels, and the drive is direct through bevel pinions, which are mounted on each end of the shaft and which mesh with corresponding gears on the barrels. As the engraving shows, these barrels may be tilted either for dumping the contents, inspecting the work, or to an angle which will give the best results. These angular adjustments may be made while the machine is in motion through a crank and gear mechanism which is easily operated. The tumbler is shown with one barrel in the dumping position and the other in the operating position. These barrels are interchangeable and they can be made of wood, cast iron, steel, sheet or cast brass. The main bearings in which the barrel shafts rotate are fitted with ring oilers affording good lubrication, and bushing bearings which may be removed when worn and replaced by new ones. The end-thrusts of the barrels are taken by adjusting screws and washers, thus relieving the gears of any unnecessary strain. Obviously, cutting down or burnishing compounds, or water



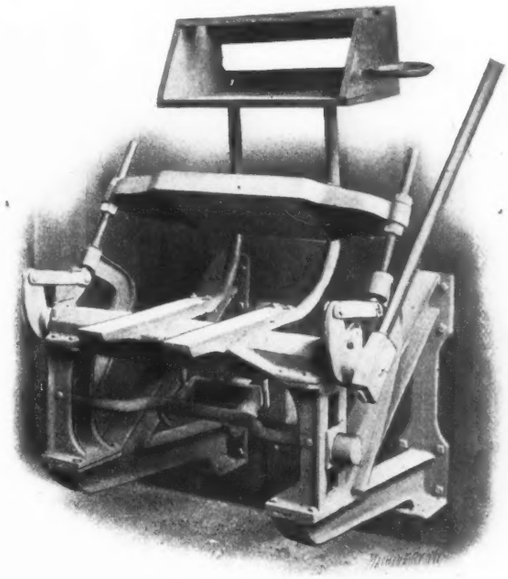
Baird Tilting Tumbler of the Duplex Type

for the purpose of cleaning the work, can be introduced into the tumblers while they are in motion.

These machines are built in two sizes, designated as Numbers 1 and 2. The first machine takes barrels ranging from 16 to 22 inches in diameter at the base, and the No. 2 machine, barrels from 22 to 36 inches in diameter. The smaller size, with 22-inch barrels, occupies a floor space of 45 by 64 inches, while the No. 2 machine with 28-inch barrels, requires a floor space of 66 by 81 inches. The respective weights of the two sizes without the barrels, are approximately 500 and 1000 pounds.

FARWELL SQUEEZER TYPE MOLDING MACHINE WITH WALL BRACKET

In the May number of MACHINERY, in the department of New Machinery and Tools, we illustrated and described some of the new molding machines recently brought out by the Adams Co., 842 White St., Dubuque, Iowa. This company has now added another type of Farwell squeezer to its line, that is designed to be attached to the wall instead of being mounted upon legs. The principal advantage of this type is that it occupies very little space, and where the floors are crowded, makes it possible to put up one or two more rows of molds. This machine would, of course, be unsuitable on long floors where considerable space is covered with molds and where a day's work is poured off at one time. It is adapted, however, for malleable foundries and other foundries in which heats are taken several times a day and where pouring is continuous. When pouring is done once a day, the molds accumulate to such an extent, that the portable type of machine is the most desirable. In fact, the ordinary portable type of squeezer is better adapted to the work of most foundries, for, by moving it several times a day, a great deal of the work of carrying molds and moving the sand is eliminated. When floors are very narrow, the broad-gage type of portable machine which

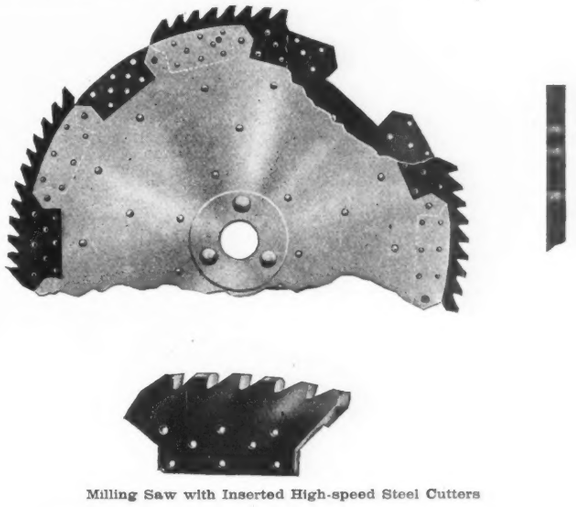


Farwell Squeezer-type Molding Machine with Wall Bracket

straddles the sand heap may be used, but such a machine must be moved quite frequently and necessitates a constant cleaning of the floor so that it is not recommended by the manufacturers where the regular portable machine can be used. The accompanying illustration shows a 30-inch machine, this dimension being the distance between the side rods, but this bracket type of squeezer will also be built in 24-, 34- and 38-inch sizes. The addition of these four sizes of bracket squeezers brings the number of molding machines manufactured by this company up to seventy-two, of various styles and sizes. It should be understood that this new machine is not intended to take the place of the stationary Farwell squeezers, or any of the other types, as it is a special design that is adapted to certain conditions.

HUTHER BROS. INSERTED TOOTH MILLING SAW

The inserted tooth milling saw shown in the accompanying engraving, is equipped with teeth made from the best grade



Milling Saw with Inserted High-speed Steel Cutters

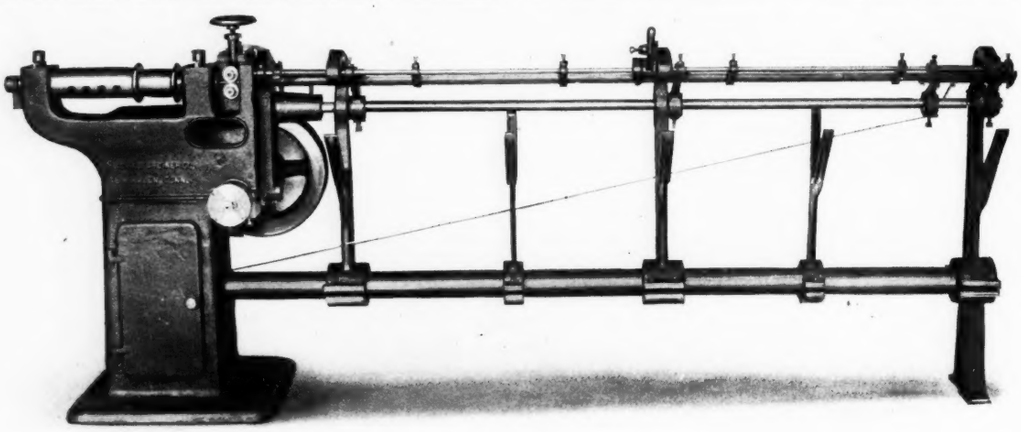
of high-speed steel, which enables it to cut hard and tough steels that would be impossible to cut with a carbon blade. The body of this saw is constructed of two crucible steel plates

which are firmly riveted together as shown. The pockets into which the teeth are inserted are cut into the plates alternately and the teeth are inserted in these pockets and securely riveted to the plates from alternate sides. The location and shape of these pockets is plainly shown in the engraving, the dotted lines indicating those in the back-plate. This method of attaching the teeth permits them to be replaced when worn, and the thickness of the saw is comparatively small which is very important, as a thin blade will cut with less strain and require less power than a thicker one. It is claimed that this saw will not fracture, as the plates are made of the best crucible steel and are given a very tough temper. Saws of this type, 32 inches in diameter and 5/16 inch thick, also 24 inches in diameter and ¼ inch thick, are being used in steel mills with satisfactory results. This construction insures a tough and rigid blade, and these saws are recommended by the manufacturers to any firm requiring high-speed steel saws, ranging from 20 to 36 inches in diameter.

GREINER AUTOMATIC WIRE STRAIGHTENING AND CUTTING MACHINE

The automatic wire straightening and cutting machine shown in the accompanying engraving, is one of a line of various sizes manufactured by the Charles Greiner Co., New Haven, Conn. The particular machine illustrated, which is one of the smaller sizes built by this company, is capable of cutting wire of ⅛ inch diameter or less, directly from the bundle into lengths up to and including 6 feet. The wire first passes through straightening rolls which are located above the column at the left of the machine. It is then fed by a roller feed past the cutting-off tool which is automatically operated by the engagement of a clutch controlled by a gage that may be adjusted for obtaining various lengths.

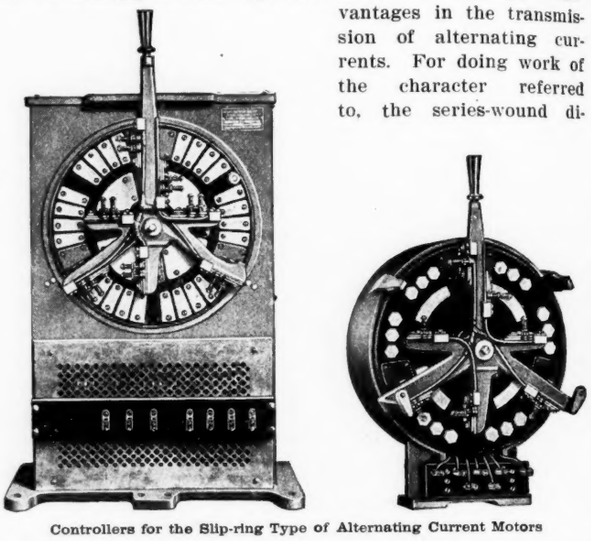
The operation of this machine is as follows: A shaft, which is about as long as the machine's capacity for cutting, is attached to the fulcrum of the cutting-off lever and rotates simultaneously with this lever. A guide-bar that is situated above and in front of this shaft is connected both with the shaft and the cutting-off lever. This guide-bar has a groove running its entire length in which is located the adjustable gage, which is connected at its outer end by a wire with a clutch on the camshaft. The wire to be cut is drawn through the rotary straightening device by feed rolls until its end strikes against this gage. The clutch, which operates the cutting-off lever, is then automatically engaged and the wire is severed. At the same time, the rotary action of the shaft throws a cover off the groove in the guide-bar by means of arms on it, and the cut wire drops into forked holders which are mounted on a piece of wrought-iron pipe. This pipe is fastened into the base of the machine at one end and it is supported at the other by a floor stand as shown in the illustration. Some of the holders extend upward and support the shaft, guide-bar and other necessary parts, thus giving strength and rigidity to the cutting-off extension. These machines are made to cut wire to almost any length in the following sizes: 1/16, ⅛, 3/16, ¼, ⅜, ½, ⅝, and ¾ inch. Each machine is capable of handling smaller diameters of wire than that indicated as its size, by equipping it with the necessary feeding and cutting-off tools. This line of tools is rigidly constructed and is designed to withstand long and continuous service. They may be used on all kinds and qualities of brass or copper, and also on tinned, black and galvanized iron, or steel wire, and for plated and highly finished wire, with satisfactory results.



Automatic Wire Straightening and Cutting Machine

ELECTRIC CONTROLLER AND MFG. CO.'S ALTERNATING CURRENT CONTROLLERS

Direct current motors, which formerly were used almost exclusively for operating electrically-driven cranes, mill machinery, etc., have been replaced in many instances, by motors of the alternating current type because of the well-known advantages in the transmission of alternating currents. For doing work of the character referred to, the series-wound direct current motor has the very desirable characteristic of a high starting torque. In alternating current motors, this feature is more often found in the slip-ring type than in the squirrel-cage type; therefore, for the operation of cranes and similar work, the development of the alternating current motor has been toward the slip-ring type.



Controllers for the Slip-ring Type of Alternating Current Motors

The speed and torque control of this motor is obtained by inserting and varying the resistance of the secondary winding by means of controllers. A complete line of manually-operated controllers of this type, ranging in capacity from 1 to 100 horsepower, has been developed by the Electric Controller & Mfg. Co., Cleveland, Ohio. These controllers, two sizes of which are illustrated herewith, follow, as closely as possible, the design and construction of the direct current controllers made by this company, and they may be used in connection with reversing slip-ring motors, operating on either the two- or three-phase system. The resistance is entirely self-contained, and it is necessary to connect only seven leads to the controller. Where heavy currents are to be handled, cast

grids resistance is employed, and unusual precautions have been taken to insure insulation which will be permanent. All the contacts, which are of heavy copper and reversible, are mounted on a vertical slate face so that dust cannot settle between the segments and cause short circuits. The use of screws or bolts with special threads has been avoided, and so far as possible, the wearing parts have been designed so they can be replaced by the user. The operation of these controllers is by a lever motion, which the manufacturers consider advantageous for crane and mill service.

AMERICAN SPEED VARIATOR FOR PLANERS

A planer speed variator of the cone-pulley type, which is now being applied to the planers of the American Tool Works Co., 300-350 Culvert St., Cincinnati, Ohio, is shown in Figs. 1 and 2. This device gives four speed changes, which are obtained through a pair of opposed four-step cone pulleys that are mounted upon a substantial platform on top of the housings. These pulleys are connected by an endless belt which is shifted from one step to another by a pair of belt forks that are moved alternately along guide rods by means of two cylindrical cams; these cams are revolved alternately by intermittent gears, operated by the handwheel shown at the rear. One revolution of this wheel shifts the belt from one step to another, and a stop pin indicates the complete revolution. The cam rolls have spiral slots milled in their peripheries and the belt forks are moved along the guide rods through the medium of a roller operating in the spiral slots. The relation between

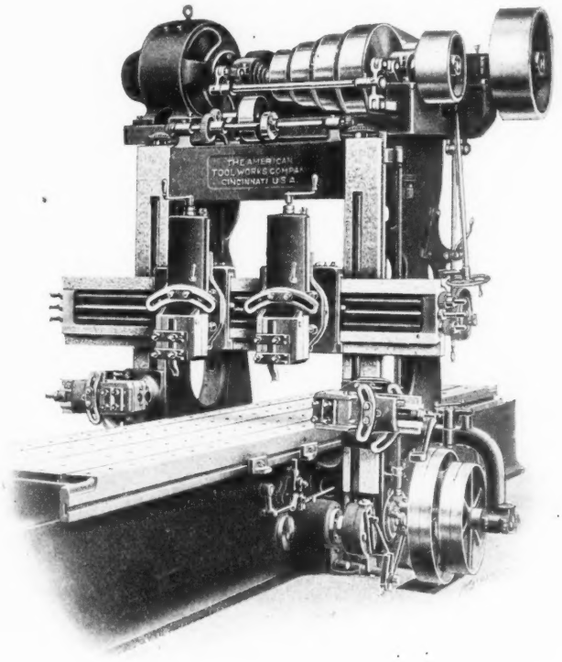


Fig 1. Planer equipped with Speed Variator

the cams and forks is such as to shift the belt off the high step of one cone before placing it on the high step of the opposing cone. The tension of the belt is controlled by the vertical lever shown at the rear, which operates a pair of bell cranks through link connections. These cranks serve to slide the driven cone towards the driver, thus slackening the belt. This feature, together with the mechanical belt-shifting device and the fact that the steps of the pulleys are beveled on the edges so as to offer no resistance to the passage of the belt, permits the making of speed changes rapidly.

After the belt is located for the desired speed, it is tightened by moving the hand lever to a point where the tension is sufficient for the work, after which the lever is securely clamped by a binder handle. As the driven cone is moved toward the driver, which carries the planer driving belts, the tension of the vertical driving belts is not disturbed when making speed changes. The speed changes can be made with this variator without stopping; in fact, it is easier to make the changes while the machine is in motion.

The driving pulleys have flywheel rims, the momentum of which reduces to a minimum all shocks to the driving mechanism due to intermittent cutting and reversing. They also insure a steady, even drive during the cut, and as they are perfectly balanced, the vibration is eliminated even on high speeds.

All the shafts of this variator are of large diameter, accurately ground and run in massive phosphor-bronze journals which are lubricated by the ring or "dynamo" system of oiling. The journals are supplied with liberal oil wells and return ducts, thereby preventing the oil from escaping and coming in

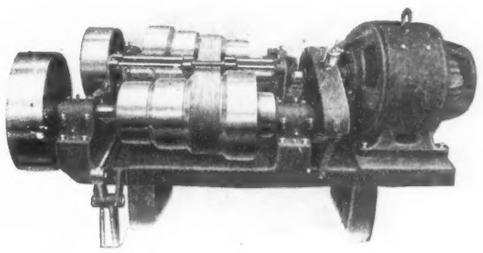


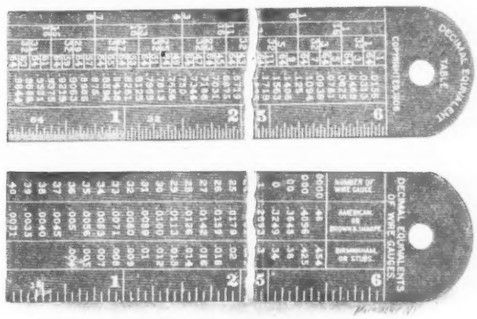
Fig. 2. View of Speed Variator from above

contact with the belts. The bearings are of the ball-and-socket type, thus insuring perfect alignment at all times.

The cutting speeds can be arranged to suit individual requirements, but, as regularly furnished, the variator gives speeds of 20, 30, 40 and 50 feet, with a constant return speed of about 80 feet. A belt drive is regularly furnished with this variator, the tight and loose pulleys being applied to the rear of the countershaft. The drive can be obtained direct from a lineshaft, provided it has sufficient speed, but slow shafts making about 150 revolutions per minute require an intermediate or jackshaft. The construction is such that it is a simple matter to convert the belt drive into a motor drive at any time after the machine is installed. The electric drive, as illustrated, may also be furnished if desired. A constant-speed motor is required, of either the direct or alternating current type. The motor is connected directly to the variator through spur gearing, and a starting box is all the controlling mechanism that is necessary. Should the motor at any time become disabled, the driving gear on the end of the variator shaft may be replaced by a pulley and the planer driven either by belt from the countershaft or by another motor.

LUFKIN DECIMAL EQUIVALENT STEEL RULE

The Lufkin Rule Co., Saginaw, Mich., has placed on the market a steel rule or scale which has, in addition to the regular graduations, tables of decimal equivalents. As such tables are often required in the machine shop and toolroom,



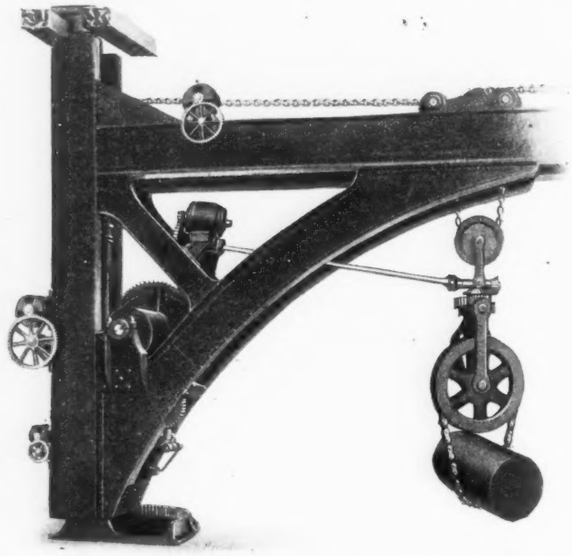
Steel Rule with the Decimal Equivalents of Fractions and Wire Gages

this rule will doubtless be appreciated by machinists and toolmakers. Both sides of the rule are shown in the accompanying illustration. One side has, in addition to a 6-inch scale with one inch graduated in 64ths and the remainder in 32nds, the decimal equivalents of all the fractional parts of an inch

by 64ths. The other side is marked with the decimal equivalents of wire gages and also a 6-inch scale graduated in 16ths. These rules are made of tempered steel and are machine divided. The surfaces are polished, and the figures and graduations are black so that they are distinct and easily read.

JOHNSTON & JENNINGS CRANE BILLET ROTATOR

The Johnston & Jennings Co., of Cleveland, Ohio, has recently designed a device for forge shop cranes, that is used for rotating billets or ingots under the hammer. The rotating mechanism of this device is power-driven, so that its use decreases the number of helpers required on the hammer crew, as it is only necessary to steady the end of the billet by balancing tongs. The drive between the motor and rotating mechanism is so arranged that it does not prevent obtaining any movement that is available with the ordinary crane, it being possible to operate the hook-block and sling chain close to the hammer or in any position on the boom. The billet and sling chain can be swiveled entirely around, as all joints in the hook-block are universal. A sprocket wheel is used for the sling chain so as to obtain a positive drive. By removing a



Crane equipped with Electrically-driven Billet Rotating Mechanism

small pin, the chain wheel can be disconnected and used without power when desired. The mechanism is very rigid and compact and is heavily designed to absorb the shocks without damage. The motor does not receive any shocks due to hammering, nor can it be injured by the billet being fast or refusing to rotate. All parts are made of either steel castings or steel forgings, and the gears are provided with cut teeth. All the bearings are bushed with bronze bushings which are self-lubricating. The lubricant is such as to withstand the heat of the billet without burning. This mechanism can be operated by the crane-man at the base of the crane, or, if desired, the crane and rotator controllers can be located near the hammer-man's position. The particular crane illustrated, which has a capacity of 25 tons, is equipped with an electric drive, but steam may be used if desired. This rotating mechanism is made for cranes of any capacity, and for either the jib or traveling type. It is effective for handling eccentric shafts, such as crankshafts, etc., as well as for round forgings, and its use would undoubtedly result in a greater output because of the increased speed of rotating and handling the work. This device enables the heaviest billets to be turned through a complete revolution in from 2 to 5 seconds.

CORRECTION

The weight of the Gardner Machine Co.'s pattern-shop disk grinder, a description of which appeared in the May number of MACHINERY, was erroneously given as 12,000 pounds. The correct weight of this grinder, complete with countershaft, is about 1200 pounds.

NEW MACHINERY AND TOOLS NOTES

Lathe Tool-holder: Lowe Tool & Machine Co., Ansonia, Conn. This is a holder of the inserted-blade type with which seven high-speed steel cutters ground to shape are furnished. These cutters are so held in the holder that they may be clamped in any one of four positions, thus adapting them to various purposes. They are made from stock sizes and may readily be obtained in the bar.

Thread Snap Gage: K. L. Herrmann, Detroit, Mich. This device consists of two hardened and lapped jaws provided with threads fastened to a C-frame. It is intended for the rapid inspection of threaded work, especially for work of large diameter and a great number of threads per inch, such as is commonly found in automobile work. The gage indicates inaccuracy in pitch, diameter and angle of thread.

"Star" Grinding Wheel Dresser: C. H. Stephan Specialty Co., Dayton, O. This tool, for truing grinding wheels, consists of a tapered tube which is filled with an abrasive. The abrasive instead of being baked in position is first made as a vitrified stick, which is afterward united to the taper tube by a metallic substance which holds it firmly. A wooden handle is inserted in the end of the tube and the dresser is used in the usual manner.

Toolmaker's Pin Vise: A. S. Koch & Sons, 143 Nevin St., Lancaster, Pa. This device is so arranged that it can be opened by one hand, while the other hand holds the work in place between the jaws. The handle consists of a sliding sleeve with a tapered end which engages the back ends of one jaw and clamps the jaw lightly against the work. A short lever which actuates an eccentric is then operated and the jaws closed firmly on the work.

Micrometer Plug Gage: Nash Engineering Co., 248 Gates Ave., Brooklyn, N. Y. This tool is intended for measuring small holes or slots with great precision. The barrel is graduated to read by thousandths and by means of subdivisions to ten-thousandths of an inch or less. This tool is nearly as rigid as a solid plug and has the advantage that intermediate sizes can be measured with accuracy, each instrument having a range of about 1/32 inch above and below its nominal size.

Hinge-joint Belt Fastener: Webb Hinge Belt Hook Co., Boonton, N. J. These fasteners are of the hinge-joint type and consist of a series of wire hooks which are inserted in the belt from both sides and clinched. The hinged connection is made by inserting a pin through eyelets or turns in the hooks which come between the belt ends. Made-up fasteners are furnished in sizes from 1 to 4 inches in width and for any thickness of belt. For wide belts a number of sets may be used.

Drill Socket: Sager Drill Socket Co., West Albany, N. Y. This drill socket is designed for holding shanks with broken tangs by the tapered part of the shank without the necessity of cutting a keyway or a flat, or using any other driving means. The socket is split and a taper sleeve screws onto the lower end of the socket. By means of this sleeve the drill shank can be firmly tightened or clamped in place. The sockets are made in several sizes for drills from ¼ to 3 inches diameter.

Measuring Device: C. J. Root Co., Bristol, Conn. This device has been designed for measuring the linear lengths of various materials during the process of manufacture. A measuring wheel mounted in a bracket rests upon the material to be measured, while a flexible shaft extends from the wheel to the counting register. The device is applied to machines through which the material passes while in the manufacturing processes. Wheels for measuring units of 12, 20 and 36 inches are furnished.

Swaging Machine: Coulter & McKenzie Machine Co., Bridgeport, Conn. This machine embodies certain improvements recently patented by Andrew Berg and is especially intended for making file tangs. The operation of forming file tangs can be accomplished in about four seconds. All the operator has to do is to place the heated stock between the dies, close the chuck mechanism and press a foot treadle. After the swaging of one tang, the swaging dies automatically open to receive another blank.

Variety Saw for Pattern Shop: B. M. Root Co., York, Pa. The countershaft by which this saw is driven, is mounted at the rear on an extension of the base. An endless belt may be used for transmitting motion to the saw arbor, as the latter with the table is adjustable horizontally. Instead of vertical adjustment for the table, the saw itself is raised or lowered by a handwheel conveniently located. The table tilts to an angle a little greater than 45 degrees and is provided with suitable graduations. This machine can be fitted with a foot-operated boring attachment if desired.

Double Back-geared Lathe: Prentice Bros. Co., Worcester, Mass. The quick-change gear mechanism of this lathe gives 36 changes of lead for screw cutting from 1 to 16 threads per inch. The lead-screw, which is large and of coarse pitch, is rotated when screw cutting only. The spindle of this machine has a 2½-inch hole through it and runs in bearings of hard bronze. The tailstock is of the offset type, permitting the compound rest to be set parallel with the bed. The feed

is automatically thrown out at any point by a stop which disengages a clutch on the feed rod. A taper attachment can be furnished, if desired, at extra cost.

Worm-gear Hobbing Attachment: Garvin Machine Co., Spring and Varick Sts., New York City. This attachment, which may be placed on the maker's milling machine tables, will permit of the cutting of two worm-gears at a time. While two gears are being cut, two previously finished gears can be taken off and new gear blanks put in place, the device having provision for the simultaneous holding of four gears. When the worm-gears are being cut, they are positively rotated; they are driven from the spindle of the machine by worm gearing to a positive clutch. The hobs are driven from the spindle by being held in an ordinary collet chuck.

Gearless Reversing Countershaft: Carl M. Wheaton, 9 Calendar St., Providence, R. I. This is a countershaft of the reversible type that is driven by a single belt and is without gears. The reverse movement is obtained by a short endless rope belt which, by passing over idlers, connects the belt pulley with the one giving the reverse motion. The desired direction of rotation is obtained by means of a clutch which connects the shaft direct to the belt pulley or indirectly through the rope drive. All parts are self-oiling and the same general constructional features employed for the regular two-pulley countershafts manufactured by the builder, are retained.

Relieving Attachment: Lodge & Shipley Machine Tool Co., Cincinnati, O. This attachment, which may be applied to this company's patent head lathe, can be used for relieving either straight or taper work, having any number of flutes ranging from 3 to 16 inclusive. A special relieving rest is furnished, which is reciprocated by a single-throw cam that is actuated from the headstock by longitudinal and cross-shafts connected by bevel gears. Multiple cams are not required as the indexing to relieve different numbers of flutes is accomplished by change gears. Three cams are furnished to give variations in the depth of relief of 1/32, 1/16 or 1/8 inch. Cams giving other throws may, of course, be easily made by the purchaser if desired.

Friction-driven Sensitive Drill Press: Barry & Zecher Co., Lancaster, Pa. This machine may be driven direct from the countershaft, as the necessary speed variations are obtained through a friction disk drive. By means of a treadle at the base, the drill is started or stopped by disengaging the friction disk, while a second treadle controls the position of the driver on the friction disk and consequently the speed of the spindle. Speed changes can be made while the machine is in motion and the available speed variations for the spindle range from 250 to 1800 revolutions per minute. The drill has a capacity for holes up to 9/16 inch in diameter. The maximum distance from the spindle to the table is 36 inches, and from the center of the spindle to the column, 13 inches.

Drawing and Broaching Press: Standard Machinery Co., 7 Beverly St., Providence, R. I. This is a press for drawing tubes in brass, gold, silver, platinum and copper, or for redrawing and broaching cups and tubes of heavy metal. The machine is designed to give a uniform pressure on the work and to draw stock evenly. It has a maximum stroke of 24 inches which may be varied to suit the work being done. The speed of the press may also be varied either by means of the lineshaft or through change gears located on top. By the use of roller thrust bearings which take the thrust of the screw and ram on both the upward and downward strokes, a considerable saving in the power required to operate the machine is said to be effected. The floor space required for this press is 3 feet, 2 inches by 7 feet, 6 inches and the extreme height is 9 feet.

Vertical Boring and Turning Mill: Betts Machine Co., Wilmington, Del. This company has brought out a new line of vertical boring mills, ranging in size from 5- to 20-foot swing. Both the vertical and horizontal movements of the heads of these machines are controlled by levers located on the heads so that the latter may be started or stopped without the operator's leaving them. The feeds may also be controlled from the heads or, if more convenient, from either side of the machine. These machines can be arranged to be driven either by motor or by belt. The cross-rail is raised and lowered and the heads rapidly traversed by a constant-speed motor mounted on the distance piece between the uprights. Each tool is independently counterbalanced by weights which do not need to be changed for any position of the cross-rail or head. On the 7-foot mill, eight feeds are provided ranging from 0.023 inch to 1 inch per revolution, which are obtained through positive clutches. All sliding surfaces are of rectangular section, the bearings are bushed with bronze, and no gears are used having less than 14 teeth.

Steam and Air Flow Meter: General Electric Co., Schenectady, N. Y. This company has developed a recording steam flow meter, two types of indicating steam flow meters, and an indicating air flow meter, each of which will accurately measure the rate of flow of steam, air or other gases under any conditions of pressure and temperature met in commercial practice. The principle governing the action is a modification of that of the Pitot tube. A brass nozzle is screwed into the pipe at the point where measurements are to be taken, having two sets of openings so arranged in relation to the direction of flow that the impingement of steam against one set results in a pressure equal to the static pressure plus the pressure due to the velocity head, while the second set is acted on by the static pressure less that due to the velocity. The difference in these values is a measure of velocity, and for constant temperature and pressure, gives the rate of flow. The pressures existing in the two sets of openings are transmitted through separate longitudinal tubes, to the outer end of the plug and from there by pipes to the meter.

Heavy-Duty Radial Drill: Edwin Harrington, Son & Co., Inc., 17th and Callowhill Sts., Philadelphia, Pa. In the design of this drill, particular attention has been given to the matter of strength and convenience of operation. The arm is rigidly constructed with cross-ribs and a large strut to prevent deflection, and it is carried on the saddle by ball thrust and roller bearings. The saddle has a vertical power traverse and a long bearing on the column. The drive is from a variable speed motor by belt to a shaft at the top of the column. Speed variations, with and without the back-gears, are obtained through a drum type controller, which is mounted on the column. When particularly slow speeds are required, they may be obtained through special gearing. Positive tooth clutches are provided in the head for reversing the drive and for engaging the back-gears, which are operated by levers located on the head. Six changes of feed are provided, ranging from 0.0051 to 0.04 inch per revolution. The spindle-reversing clutch on the horizontal shaft permits tapping without the use of an extra attachment. These drills are made in two sizes having 5- and 6-foot arms. A 20-horsepower motor is supplied with each machine, and the respective weights are 17,000 and 18,000 pounds.

Sprue Press: Standard Machinery Co., 7 Beverly St., Providence, R. I. This is a press that has been designed to meet the needs of brass founders and other manufacturers for a machine to cut the sprues or gates from soft metal castings. It is a modification of the company's style D power press. Both a treadle and hand lever are furnished for controlling the clutch mechanism, so that when necessary the operator can have both hands free to hold and guide the work, the machine stopping automatically at the upward end of the stroke. The cutters are made of open-hearth tool steel, and are two inches square in section, so that they may be made from plain bar stock. Provision is made for adjusting these cutters so that they may be accurately set to just cut off a gate without touching each other, thus preserving the cutting edges. When it is found more convenient to present the work from the side of the machine, the cutters may be turned at right angles to the normal position. The patented instantaneous clutch with which this press is fitted is so designed that the machine can be run continuously or stopped instantaneously after each revolution. This clutch, which is of the Horton type, illustrated in an article on "Clutches for Power Presses," in the November, 1908, number of MACHINERY, operates so quickly that there is less than 1/32 inch travel on the periphery of the flywheel, after the clutch mechanism is engaged or disengaged, thus insuring efficient operation.

Turn-table Lathe: Pratt & Whitney Co., Hartford, Conn. The tool-carrying cross-slide of this machine is provided with a plain rotary table of hexagon shape onto which the tools are clamped. The machine derives its name from this rotary table. It is intended for the machining of bar stock, castings and forgings, and it has a capacity for bar stock up to 2½ inches diameter and turns a maximum length of 26 inches. The swing over the bed is 20 inches and the swing over the forming slide is 11 inches. The machine is provided with a geared head and single-pulley drive, the gearing in the head giving eight speed changes for the spindle, the speed ranging from 10 to 251 revolutions per minute. An automatic chuck and rod feed mechanism of the same design as that provided on the Pratt & Whitney open turret lathe described in MACHINERY July, 1907, is also applied to this machine. A feed gear box is placed beneath the head in front of the machine. This gear box provides for six feed changes. The stops for the cross-slide are arranged in a similar manner as on the maker's regular turret lathes, six regular and three supplementary stops being provided. Power and hand feed are provided for the cross-slide in both directions. The turn-table or top of the cross-slide is indexed either automatically when the carriage is run back or directly by hand. The machine can be either belt- or motor-driven, the motor being 7½ horsepower.

Universal Triple-Geared Radial Drill: American Tool Works Co,, 300-350 Culvert St., Cincinnati, O. This is a powerful triple-geared radial drill of the universal type, designed to meet the demand for a tool having a wide range of usefulness and at the same time the required power, rigidity and durability to withstand the heavy duty imposed by the use of high-speed steels. One of the striking features is the design of the arm, which has been made exceptionally rigid to resist the combined strains of torsion and deflection. This arm is made in the form of upper and lower tube sections which are bound together in the back by a double wall of metal and further reinforced by heavy transverse ribbing. By means of a worm-

wheel, which engages with teeth cut in the flange of the arm, the latter may be rotated in a complete circle. This movement in connection with the angular adjustment of the head makes it possible to drill and tap to any angle radiating from the center of a sphere. The head of this machine is very compact in its design and is equipped with powerful steel triple gears. The spindle is provided with 24 speed changes ranging from 19 to 314 revolutions per minute in geometrical progression. The tapping mechanism is interposed between the triple gears and the speed box, being mounted in the column end of the arm. By placing the tapping mechanism in this position, it receives the benefit of the triple gear ratio, thus making possible unusually heavy tapping without undue strains and at the same time permits the backing out of taps at an accelerated speed. The lever for operating it is placed on the front of the saddle and controls the starting, stopping and reversing of the spindle. The speed box is of the cone-and-tumbler type and provides eight changes of speed, any one of which is instantly available by shifting the tumbler gear lever to the proper position. By means of an auxiliary train of gearing placed between the pulley and cone shafts, the cone gears are automatically rotated when speed changes are being made, so that undue shocks to the gears are avoided. The driving mechanism is further protected by a flexible coupling or cushion interposed in the line of drive for the purpose of absorbing shocks.

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NATIONAL ASSOCIATION OF MANUFACTURERS' CONVENTION

The fifteenth annual meeting of the National Association of Manufacturers was held in New York, May 16, 17, and 18, the Waldorf-Astoria being the headquarters. The registered attendance, including members and visitors, was 321. The proceedings of this association are largely of a semi-political character, questions of governmental policy, foreign relations, the tariff, patents, immigration, internal commerce, waterways, merchant marine, conservation of resources, etc., being subjects of committee reports. Industrial accidents, means of prevention, and liability insurance, which are of direct and vital importance to every manufacturer, were very practical matters that received attention, however. The program included the following, bearing on them:

An illustrated lecture by Prof. Frederick R. Hutton, "The Prevention of Industrial Accidents";

Address by Henry L. Rosenfeld, "Cooperation and Compensation vs. Compulsion and Compromise in Employers' Liability";

Address by Miles M. Dawson, "True Economy in Compensation for Industrial Accidents," etc.

The report of the committee on industrial indemnity insurance comprising insurance against accidents, sickness and old age; home acquirements, safety appliances and prevention of accidents, etc., probably is one of the most thoroughgoing documents on the subject ever presented. It is authoritative, and represents a large amount of labor in the collecting of the information from manufacturers, government statistics, reports, and other sources. The workings of the present liability insurance system were denounced, and an employers' mutual indemnity insurance system, providing for accidents, sickness and old age was recommended. Liability insurance is a wasteful system of protecting the manufacturer. The defense of damage suits clogs the courts; it is said that from one-third to one-half the time of the state and federal courts is taken up with accident damage suits, and that less than 30 per cent of the premiums paid by employers reach the injured or the dependents of the killed. The report recommended that annual prizes of $10,000 be offered for the safest plants and the best means of accident prevention.

Honor was paid to the late James W. Van Cleave, former president of the association, by a memorial service at 4 o'clock May 17, when the funeral was being held in St. Louis. Glowing tributes were paid to his courage and aggressive qualities.

John Kirby, Jr., president, and F. H. Stillman, treasurer, were both re-elected.

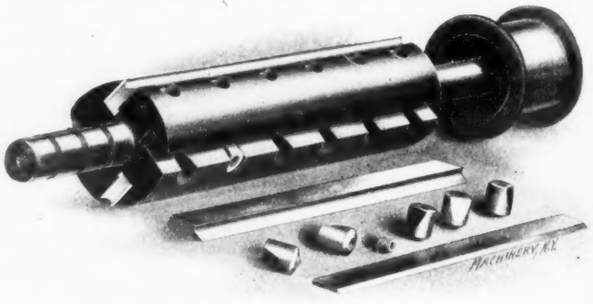
Nearly 400 attended the banquet at the Waldorf-Astoria Wednesday evening at which Speaker Joseph G. Cannon, of the House of Representatives, was the principal speaker.

* * *

Flaming arc lamps are used for interior lighting with great success by the H. H. Franklin Mfg. Company, Syracuse, N. Y.

SAFETY HEAD FOR WOODWORKING MACHINE

A simple method of safeguarding workmen from the knives of cutters of a jointer, has been developed by the Crescent Machine Co., Leetonia, Ohio. This company has applied to machines of this type, a cylindrical cutter head, such as is shown in the accompanying illustration, which, by reason of its shape, is much safer than the square type commonly used. In case the hand gets in contact with the knives of this new safety head, as it has been appropriately called, a flesh wound



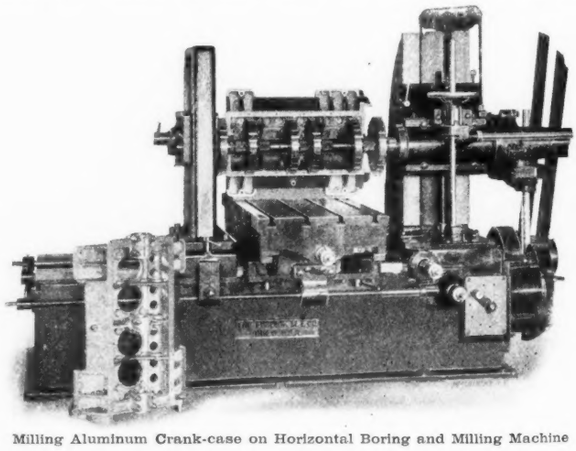
Cylindrical Cutter Head for Jointer, designed to minimize Injuries

would be about the limit of the injury, whereas with the square type of head, there is great danger of the hand being drawn in, resulting in the loss of fingers or in a more serious injury. The reason for the comparative safety of this new head is plainly indicated by the illustration. In conjunction with this head, there is also used a protective shield or guard, which is intended to cover the unused portion of the cutters. The safety head affords protection, however, even though the workman neglects to use the guard, as it minimizes the extent of the injury.

* * *

BORING AND MILLING OPERATIONS ON ALUMINUM CRANK-CASE

An interesting machining operation that is performed on the crank-case of the "Cino" motor in the shops of Haberer & Co., Cincinnati, Ohio, is illustrated herewith. The casting is of aluminum and all the operations of boring and milling are done on the horizontal machine shown. The first operation is that of milling the top face. The piece is then put in a jig where all the holes are drilled, after which it is returned to the horizontal boring machine where the crank-shaft holes and



Milling Aluminum Crank-case on Horizontal Boring and Milling Machine

cam-shaft holes are bored by means of a double boring-bar. The next operation is that of facing the ends of the crank-shaft holes, which is accomplished in the manner illustrated. Six straddle mills are mounted on a bar with adjustable spacing collars between them. Each mill takes a cut ¼ inch wide, with a feed of 0.0155 inch per revolution of the spindle, on each of the six faces at the same time. The spindle runs at 30 revolutions per minute, which gives a peripheral speed to the cutters of about 85 feet per minute. This particular operation on the crank-case takes only fifteen minutes, which includes the time of setting up and taking down. The machine on which this work is done is built by The Fosdick Machine Tool Co., Cincinnati, Ohio.

HERRICK BALANCED ROTARY ENGINE

A new type of rotary engine that promises to be of commercial value in connection with marine work, if not in other fields, was formally exhibited at the Waldorf-Astoria, Saturday evening, May 21, before a large gathering of engineers. This new engine, which is the invention of Mr. Gerardus P. Herrick, differs from the countless designs which have preceded it, principally in an ingenious method employed for counterbalancing the radial load on the bearings, which in other rotaries has resulted in serious loss of power through

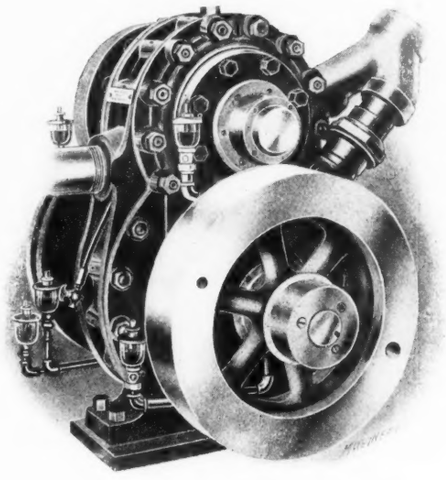


Fig. 1. The Herrick Rotary Engine

excessive friction. The way in which this counterbalancing effect is obtained, as well as the operation of the engine itself, will be explained in connection with the accompanying illustrations, Figs. 1 and 2, which show, respectively, general and sectional views of the experimental motor.

This engine has two rotating cylindrical members *A* and *B*, which are mounted in bearings placed just far enough apart to obtain a rolling contact between the peripheries. The lower part *B* is the rotor to which is attached a single impeller blade against which the steam acts. The upper part *A* is, in reality, a valve which controls the admission of steam. This valve also serves, by its contact with the rotor, to separate the steam and exhaust spaces of the cylinder. The rotor and valve are connected by herringbone gears *C* of the same size which give these two parts synchronous movements. A circular recess is cut in the periphery of the valve, as indicated by the dotted lines in the elevation, which meets the impeller blade *D* at each revolution and allows it to pass without contact. When this recess moves around to the point where it connects with the steam port which communicates with the pipe *F*, steam is admitted to the space between the blade *D* and the contact point between the rotor and valve. When the valve moves to the position shown in Fig. 2, the steam is cut off and used expansively throughout the remainder of the revolution. As soon as the impeller blade passes port *E*, the exhaust takes place. The recess in the valve has then moved around to allow the blade to pass, which completes the cycle.

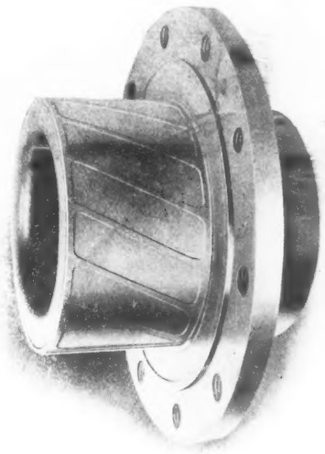


Fig. 3. Enlarged View of Balancing Plug showing Balancing Chambers

The casing which forms the cylinder, has side plates bolted to it, to which are attached, concentric with the valve and rotor shafts, what are known as "balancing plugs." These plugs fit closely into annular spaces on each side of the central webs of both the valve and rotor, and contain the packing and bearings. They are also provided with shallow chambers on their peripheries, as shown in the enlarged view, Fig. 3. The way these plugs are utilized in balancing is as follows: As the steam enters the cylinder, a small amount passes through holes located just back of the impeller blade (these are indicated at *G* in Fig. 2) to a chamber of the balancing plug, and then to successive chambers as the rotor revolves, thus introducing into each chamber a film of steam, the pressure of which gradually decreases as the steam expands. As these balancing plugs are lengthened sufficiently to compensate for their small diameter, theoretically the radial thrust from the pressure on part of the exterior surface of the rotor, is counter-

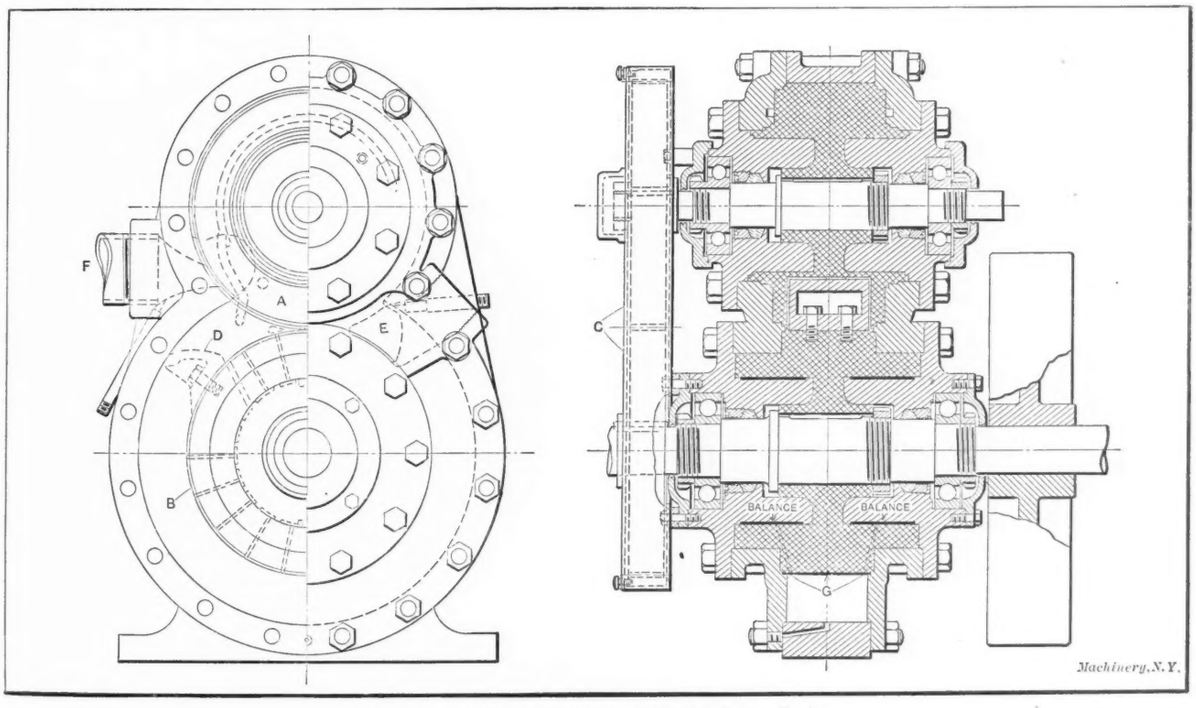


Fig. 2. Elevation and Section of the Herrick Rotary Engine

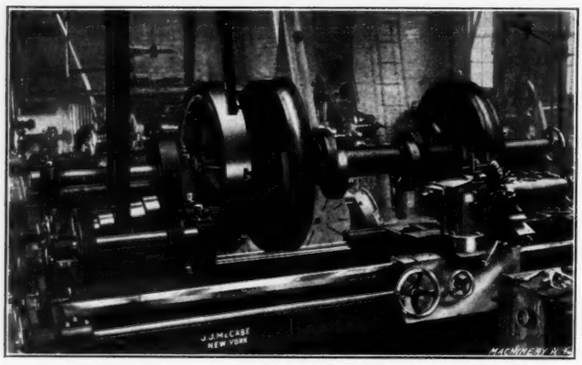
balanced by this inner steam film which rests against the inner wall of the rotor. It will be seen that as the pressure area on the outside of the rotor increases, the balancing area between the plugs and the inside of the rotor also increases.

Mr. Luther D. Lovekin, Chief Engineer of the New York Shipbuilding Co., has suggested that this engine could be advantageously used in connection with turbines for ship propulsion. The plan is to use a three-shaft installation, the two wings or outer shafts being driven by turbines and the central shaft by a rotary engine interposed between the boilers and turbines. By this arrangement, high-pressure superheated steam, which cannot be used economically in turbines without greatly increasing their weight and size, could first be utilized in the rotary, from which it would be exhausted at the most suitable pressure for economy in the turbine. This plan has been indorsed by Captain A. B. Willis, U. S. N., who further recommends that three separate rotaries (not compounded) with impeller blades located 120 degrees apart, be used in order to obtain a better balance and a steadier steam flow to the turbines. The construction of this new rotary is such that the rotating surfaces do not come into actual contact within the steam space, which, while it reduces the friction, results, of course, in some leakage. Such leakage, however, with the roto-turbo combination will pass out through the exhaust and be utilized in turbines. Mr. Lovekin estimates that by this arrangement a water rate of ten pounds per brake horsepower per hour, can be obtained.

* * *

TURNING LOCOMOTIVE DRIVING WHEELS IN A McCABE DOUBLE-SPINDLE LATHE

An excellent example of the adaptability of the double-spindle lathe, particularly for shops handling a large variety of work with a more or less limited tool equipment, is shown by the accompanying engraving. The particular work illustrated, is that of re-turning the tires of a pair of locomotive driving wheels in the Empire Machine Works of Brooklyn, N. Y., on one of the J. J. McCabe double-spindle lathes. These



Turning the Tires of a 48-inch Driving Wheel in a McCabe Double-spindle Lathe

wheels are 48 inches in diameter, the width of the tire is 6 inches, and the approximate weight is 7000 pounds. As they had been in constant service both night and day for two years, they were not only badly worn, but extremely hard, owing to the chilled spots due to the braking action and the slippage between the wheels and the rails. By doing this job in the machine referred to, it was unnecessary to send the wheels to Philadelphia to be turned on a regular wheel lathe as formerly. By the use of an auxiliary tool-stand that may be attached to one side of the saddle, two tools were used simultaneously to cut down the ridges on either side, which reduced the time required for the turning operation.

* * *

LAUNCHING OF THE FLORIDA

The U. S. S. *Florida*, which, when completed, will be the largest battleship in the United States Navy, was launched at the Brooklyn Navy Yard on Thursday, May 12. The *Florida* will have a normal displacement of 21,825 tons, which exceeds the displacement of the *Connecticut* by 5825 tons, and that of the *Oregon* by 11,537 tons. Her length over-all is 521 feet, and her width of beam, 85 feet. The armament consists of ten 12-inch rifles in the main batteries, and sixteen 5-inch rapid-fire guns, four 3-pounders, two 1-pounders, and a number of machine guns in the secondary batteries. There are also two 21-inch submerged tubes for torpedoes. The broadside fire will be 20 per cent greater than any battleship in commission in our navy. The engines are of the turbine type and are designed to develop 28,000 horsepower, which will give an estimated speed of approximately 22 knots. Propulsion is obtained through four propellers, being arranged in tandem on each side of the twin shafts. When launched, the *Florida* weighed approximately 8700 tons, and she was 65 per cent completed. Her estimated cost at completion is $6,000,000.

* * *

THE NEW CINCINNATI PLANER PLANT

Five of the largest concerns connected with the Cincinnati machine tool industry have formed an industrial colony at Oakley, Ohio, which is only a few miles out of Cincinnati. These concerns are the Cincinnati Planer Co., Cincinnati Mill-

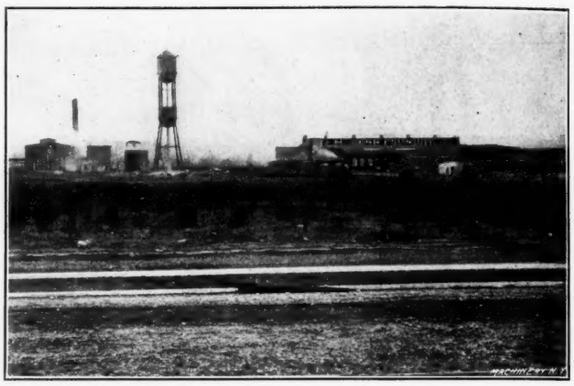


Fig. 1. Colony Power Plant and Modern Foundry Co.'s Plant, Oakley, Ohio

ing Machine Co., Cincinnati Bickford Machine Tool Co., Triumph Electric and Ice Machine Co. and the Modern Foundry Co., and they all own a power plant in common, the stock ownership of which is proportioned to the amount of power used. This power plant furnishes power, light, service water, sprinkler water, compressed air, steam line and hot water for heating plants. As noted elsewhere, the Triumph plant is already in complete operation; so too are the Modern Foundry Co. and the Cincinnati Planer Co., the latter having entirely vacated its old plant in Cincinnati.

Pictures of the Modern Foundry's Co.'s plant and the common or colony power plants are shown in Fig. 1 and in Fig 2 is the Cincinnati Planer plant. A general view of the shop interior

Fig. 2. Cincinnati Planer Co.'s Plant, Oakley, Ohio

of the latter place is given in Fig. 3 and shows the magnificent lighting, and the crane system; in the lower left-hand corner are shown the tops of freight cars which are run into the shop on depressed tracks, capable of holding two 40-foot cars, which bring the floor of the cars on a level with the shop floor.

Each department is driven by individual motors, the line-shaft being in sections. Hyatt roller bearings are used on all shafts and the method of mounting the motors is somewhat

unusual. In the first place the shop floor is composed of about eight inches of cinders, eight inches of concrete, then creosoted sleepers imbedded 'n concrete, next 1⅝-inch of oak and lastly a layer of easily renewable ⅞-inch oak flooring. The motor foundations are built up like a big concrete box, directly from the eight-inch concrete foundation. These hollow motor foundations average about three feet in height and are filled with cinders, on top of which is placed four inches of oak as shown at *A*, Fig. 4. The motors are bolted down solidly by bolts imbedded in the concrete. The construction of the motor foundations in this way does away with the vibration present when

Fig. 3. Interior View of Cincinnati Planer Co.'s Shop

they are placed on platforms in the usual way, and it also provides means of oiling and inspecting without using a ladder. This engraving also shows one of the short shafts at *B* used for testing planers in position before shipping.

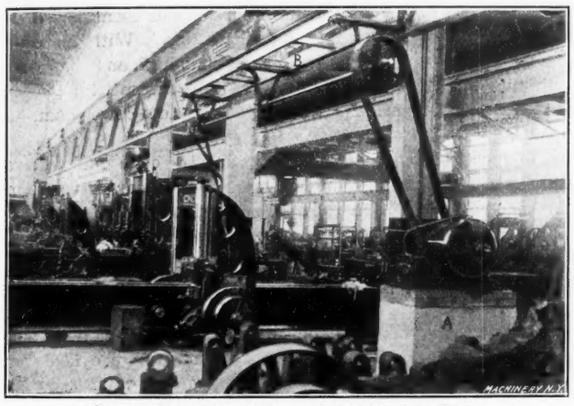


Fig. 4. Motor Foundation and Test Shaft in Shop

Fig. 5 shows a small section of the individual locker and wash-bowl system, which is only one of the many features of the plant designed to provide for the comfort of the employes.

* * *

Cement will resist a temperature of 500 degrees F. for an indefinite period, but a continuous temperature of over 700 degrees F. is disastrous. The heat-resisting power of cement is due to the amount of moisture chemically combined, being from twenty to twenty-five per cent of its weight. At a high temperature this chemically-combined water is driven

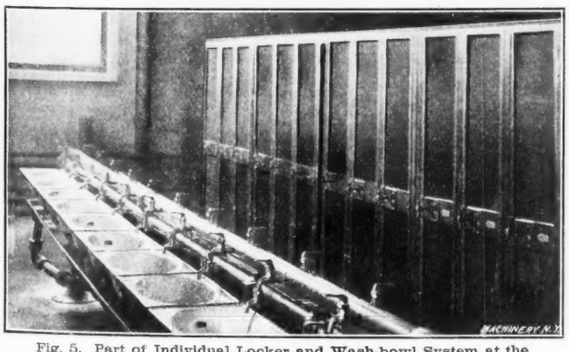
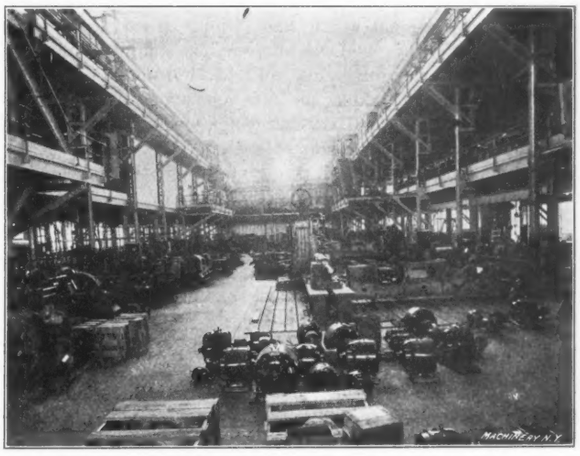


Fig. 5. Part of Individual Locker and Wash-bowl System at the Cincinnati Planer Shops

off, but slowly, and the cement will not crumble until the water has been evaporated. The slowness of evaporation is probably the cause of the ability of concrete to resist high temperatures for a short period, while a much lower temperature, long continued, will ultimately disintegrate it.

OPENING OF NEW PLANT OF TRIUMPH ELECTRIC CO. AND TRIUMPH ICE MACHINE CO.

A special B. & O. railway train carried 350 visitors from Cincinnati to Oakley, Ohio, to the opening of the Triumph Electric, and Triumph Ice Machine Co.'s new plant, Saturday, April 30. In addition to these about 150 more made the trip in



New Machine Shop of Triumph Electric Co. and Triumph Ice Machine Co., Cincinnati, Ohio, 300 feet long, 140 feet wide, Center Bay 60 feet

automobiles and street cars. Buffet lunch was served, after which John L. Shuff, acting as chairman, introduced W. N. Hobart, the venerable head of the concern, who made a short speech. He was followed by James J. Heekin, president of the Chamber of Commerce; A. J. Conroy, president of the Business Men's Club; President Egan of the Industrial Bureau; W. F. Robertson of the Manufacturers' Club, and R. K. LeBlond of the Metal Trades Association. After the close of the speeches, all of which were brief and to the point, the guests were divided into groups with a guide at the head and shown over the plant.

An interesting feature of the plant is the position of the various store-rooms which are situated in the middle gallery either directly above, or directly below, the department which they are to serve, thus reducing the trouble of getting stock promptly, to a minimum. The view reproduced herewith shows the main machine shop, which is 300 feet long and 140 feet wide. The center bay is 60 feet wide.

* * *

SPRING MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The program of technical papers for the American Society of Mechanical Engineers' convention, which will be held in Atlantic City, N. J., May 31 to June 3, is as follows:

"The Shockless Jarring Machine," by Wilfred Lewis.

"A Comparison of Lathe Headstock Characteristics," by Prof. Walter Rautenstrauch.

"The Strength of Punch and Riveter Frames Made of Cast Iron," by Prof. A. L. Jenkins.

"The Mechanical Engineer and the Textile Industry," by H. L. Gantt.

"The Elastic Limit of Manganese and other Bronzes," by J. A. Capp.

"The Hydrostatic Chord," by R. D. Johnson.

"The Resistance of Freight Trains," by Prof. Edw. C. Schmidt.

"A Regenerator Cycle for Gas Engines Using Sub-adiabatic Expansion," by Prof. A. J. Frith.

"Gas Engines for Driving Alternating Current Generators," by H. G. Reist.

"Two Proposed Units of Power," by Prof. William T. Magruder.

"Some Operating Experiences with a Blast Furnace Gas Power Plant," by H. J. Freyn.

"Improvements in Lineshaft Hangers and Bearings," by Henry Hess.

"Experimental Analysis of a Friction Clutch-Coupling," by Prof. William T. Magruder.

"An Improved Absorption Dynamometer," by Prof. C. M. Garland.

"Critical Speed Calculation," by S. H. Weaver.

NATIONAL MACHINE TOOL BUILDERS ASSOCIATION CONVENTION

The semi-annual convention of the National Machine Tool Builders' Association at Rochester, N. Y., May 24 and 25, was the most successful spring meeting ever held, the attendance breaking the record for a semi-annual convention. Twenty-one new members joined—the largest number of accessions at any meeting.

F. A. Geier, president of the association, called the meeting to order and in a few well-chosen remarks congratulated the members on the progress made and the mutual good feeling engendered. He contrasted the members' relations with the conditions existing abroad, especially in Germany, where practically no cooperation whatever exists, and where almost every machine tool builder regards his competitors with suspicion and distrust. Great regret was expressed for the illness of W. P. Davis, president of the W. P. Davis Machine Tool Co. of Rochester, through whose efforts, largely, the meeting was held in Rochester.

After the transaction of the routine business came the reports of committees, the first being that of the committee on standardization of motors, of which Paul A. Montanus, of the Springfield Machine Tool Co., Springfield, Ohio, was chairman. The report gave the substance of the conference of the committee with a similar committee appointed by the American Association of Electric Motor Manufacturers. Fifteen principal points of discussion were presented, of which eight had been agreed on, the remainder having been left for further discussion. The results of the committee work will be published when it has been completed.

The Committee on Uniform Costs, of which E. J. Kearney, of Kearney & Trecker Co., Milwaukee, Wis., was chairman, was represented by S. H. Reck of the Rockford Drilling Machine Co., Rockford, Ill., in the absence of Mr. Kearney. A communication from the latter expressed satisfaction with the uniform costs system installed in the Kearney & Trecker plant.

The Apprenticeship Committee, of which E. P. Bullard, of the Bullard Machine Tool Co., Bridgeport, Conn., was chairman, was represented by F. L. Eberhardt, who read a paper giving an outline of the apprenticeship system in operation in the plant of Gould & Eberhardt, Newark, N. J.

The Tariff Committee, of which J. B. Doan, of the American Tool Works Co., Cincinnati, Ohio, was chairman, rendered a report which briefly reviewed the work and gave some statistics of the present tariff, including the minimum and maximum features.

The cancellation of machine tool orders was ably discussed by C. Wood Walter, C. A. Johnson, Murray Shipley and William B. Reid, the first three taking the manufacturer's side. It was practically agreed that present trade practice is unsound, too much looseness existing in the character of orders and in permitting cancellations without adequate cause. Parallel conditions exist in no other industry. The privilege of cancellation is abused. Customers and dealers place orders on chance. If the business materializes the machines are accepted, but if not, the orders are countermanded without thought of the hardship inflicted on the machine tool builder. The injurious effects of this system of doing business are so obvious that no great argument was necessary to prove them. Mr. Reid, representing the dealers, conceded much that had been said. He stated, however, that 80 per cent of the machine tool trade is done through dealers and that grave practical difficulties prevent any radical change in a system that has become strongly established by custom. If the builders were unwilling to practically carry stock in the dealers' warerooms in good times, through permitting cancellations at will, they should not in justice ask the dealers to order stock in dull times.

Prof. F. B. Dyer, superintendent of Cincinnati public schools, described the work of the Cincinnati continuation school and illustrated the character of instruction with stereopticon views. (See MACHINERY, May, 1910, for abstract of similar paper.) His talk evoked hearty applause and many members evinced great interest in the school work, which undoubtedly is a forerunner of one of the most important educational works that has been undertaken in America along industrial lines.

Robert Pierpont, works manager of the Olds Motor Works, Detroit, Mich., read a paper on the future of the automobile business with reference to machine tools, in which he set forth some very practical ideas developed from experience in the management of one of the large automobile factories. He advocated special machinery and simpler standard tools. In his opinion individual motor drive is best adapted to special machines in which the power consumption is practically a fixed quantity. On standard tools, where the power requirements vary widely, the motor equipment is necessarily greater in power than the total required for a group of the same machines when driven by a motor direct connected to the lineshaft. He advocated cone drive in preference to gear drive as the latter is likely to be noisy and inefficient. Suggestions were made regarding milling machines, lathes, grinders, drilling machines, screw machines, gear cutters, and special machinery.

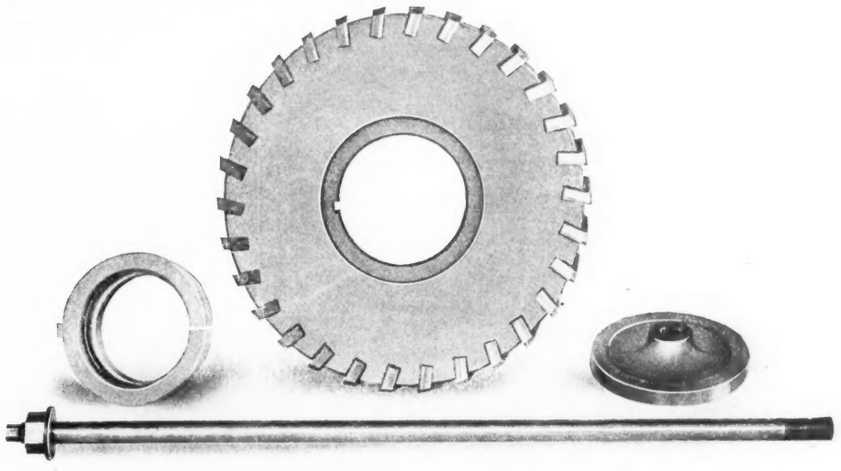
R. K. LeBlond of the R. K. LeBlond Machine Tool Co. and William Lodge of the Lodge & Shipley Machine Tool Co., discussed the relative merits of cone drive and gear drive, the former advocating the cone drive and the latter the gear drive. Mr. LeBlond claimed that all the advantages that can possibly be secured with the gear head can be better obtained with a variable speed motor and comparatively few mechanical changes, because the changes can be obtained with small friction loss. In his opinion the great difficulties of all gear-driven machines are lack of efficiency, expensive maintenance and increased first cost. It was pointed out that the single-pulley gear-drive 16-inch lathe required a one-horsepower motor to turn it over, and fully one-half horsepower is absorbed in friction loss under actual working conditions. With the cone pulley drive on direct speeds an efficiency as high as 85 per cent is obtained and in the extreme cases of transmitting power through the back gears the efficiency is seldom lower than 75 per cent.

Mr. Lodge conceded that for light work the cone pulley drive can be used to advantage, but advocated the gear drive when taking heavy cuts at high rates of speeds, the power consumption then being increased from two to five times the ordinary ratings.

William R. Wood of Cincinnati, Ohio, read a paper advocating a court of patent appeals. He referred to the importance of patents in the machine-tool manufacturing business and the hopeless discrepancies between the means provided for securing patents and for protecting the patent when secured. The Patent Office represents one piece of the patent machinery and the United States courts the other. The application for a patent receives the most careful scrutiny, and thorough examination is made into the state of the art before the patent is granted. The time required for securing a patent may vary from six months to six years and when granted it is supposed to give the inventor a monopoly for a period of seventeen years. After all the elaborate precautions have been taken by the examiners, we have the glaring inconsistencies of the courts in passing on the validity of the patents so cautiously obtained. The United States courts have exclusive jurisdiction in patent suits and, with all due respect to the attainments of the learned judges comprising the court, it must be conceded that they have not the experience that qualifies them to pass on many questions of purely mechanical merit. The American Bar Association, the Washington Bar Association and many members of the patent bar, are in favor of creating a patent court of appeals composed of five judges selected from the thirty regular circuit judges with special view of their fitness, to whom all patent suits shall be taken. A bill has been introduced to the Senate, known as Senate Bill No. 4982, and a similar bill has been brought before the House of Representatives, known as House Bill No. 14,622.

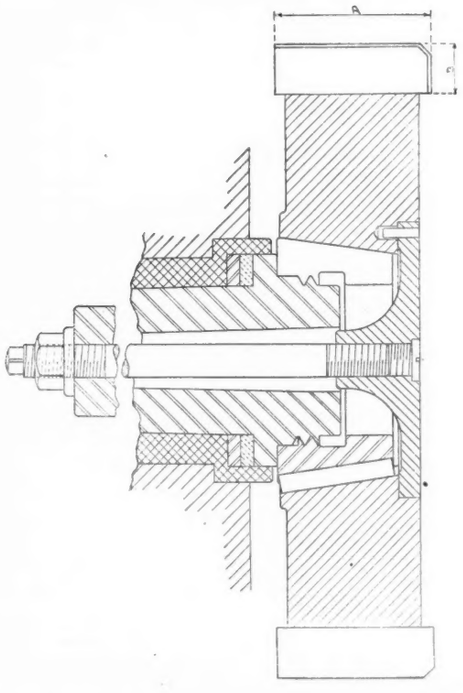
A new and original feature, and one of the most interesting in the proceedings to the newspaper men, was the discussion of the value of what was called "Direct Advertising," represented by A. H. Hitchcock of *Hitchcock's List*, and "Trade Paper Advertising," by John A. Hill of the *American Machinist*. A raised platform for the participants, equipped with buckets of water, boxing gloves and sponges created great merriment as the members assembled in the hall. The speakers were placed in chairs. Charles G. Allen of Barre, Mass., seconded

Why do you keep a large number of face milling cutters on hand when you can use one on several sizes of machines?



B. & S. Inserted Tooth Face Milling Cutters

can be used interchangeably on machines of different sized spindles and so greatly reduce the number of cutters necessary to keep on hand.



The cutters are made to fit over a split sleeve which screws on to the nose of the spindle. When it is desired to use one cutter on different sized spindles, the internal diameter of the sleeves varies to fit the different spindles but the external diameter of the sleeves is the same.

Another advantage of the cutters is the fact that the sleeves are made with a taper that will allow for ready release when it is desired to remove the cutter.

The theory of the cutter allows for taking the heaviest cuts, as all danger of jamming the cutter on the nose of the spindle is eliminated. Thus the capacity of the cutter is limited only by the full power of the belt.

Send for our new Cutter List.

BROWN & SHARPE MFG. CO., Providence, R. I., U.S.A.

Mr. Hill and A. E. Newton of Worcester, Mass., Mr. Hitchcock. Edward Rivett of Brighton, Mass., acted as referee. Our limited space prevents an extended report of the papers, but those who are acquainted with the speakers will agree with us that both sides were ably presented, the discussion being declared a drawn battle by the referee.

One function of the trade journal, and an important one, which is sometimes lost sight of by advertisers who consider direct results only, is the educational and informative work the best trade journals perform in their respective fields, and which indirectly brings more and better results to manufacturers than their advertising. We need only point to the progress of the machinery trade in this country, which is coincident with the development of the trade journals in this field, to prove the necessity for their existence, even if they brought no returns whatever to an advertiser.

The social event of the meeting, long to be remembered with pleasure by those participating, was the reception, Tuesday evening, given by Miss Kate Gleason and brother, William Gleason, of the Gleason Works, Rochester, at their "Spanish castle" home "Clonos" on East Ave., Pittsford, a suburb of the city. About 180 machine tool builders, friends, guests and ladies were taken there by automobile. The unique architectural features of "Clonos" inspired the liveliest interest, and the entertainment left nothing to be desired.

There are now 116 members in the association including the new members added at this convention, the names of which are as follows:

Adams Co.....Dubuque, Iowa.
Baker Bros.....Toledo, Ohio.
Becker Milling Machine Co.....Hyde Park, Mass.
Bridgeford Machine Tool Works.....Rochester, N. Y.
Betts Machine Co.....Wilmington, Del.
Bryant Chucking Grinder Co.....Springfield, Vt.
Foster Machine Co.....Elkhart, Ind.
Edwin Harrington Son & Co., Inc.....Philadelphia, Pa.
Landis Tool Co.....Waynesboro, Pa
Leland, W. H. & Co.....Worcester, Mass.
Moline Tool Co.....Moline, Ill.
Morton Mfg. Co.....Muskegon Heights, Mich.
New Haven Mfg. Co.....New Haven, Conn.
Oesterlein Machine Co.....Cincinnati, Ohio.
Pratt & Whitney Co.....Hartford, Conn.
Rochester Boring Machine Co.....Rochester, N. Y.
William Sellers & Co., Inc.....Philadelphia, Pa.
Taylor & Fenn Co.....Hartford, Conn.
Universal Boring Machine Co.....Hudson, Mass.
Walker Grinder Co.....Worcester, Mass.
Waltham Watch Tool Co.....Springfield, Mass.

The officers and committees are to be congratulated on the results of the work, which has greatly strengthened the association, and which undoubtedly has contributed materially to general information on technical and practical matters of great moment to the members. The fall meeting will be held in New York City.

* * *

PERSONALS

E. A. Murray, general foreman of the C. & O. R. R. shops at Covington, Kentucky, has been promoted to the position of master mechanic of the Lexington shops.

J. H. Nash, master mechanic of the Illinois Central Ry. shops at Paducah, Kentucky, has just been given the position of superintendent of the Burnside shops of the same road.

J. E. Parker, formerly connected with the H. Mueller Mfg. Co. of Decatur, Illinois, has taken a position as steel expert and traveling salesman with the Crucible Steel Co. of America, his headquarters being at Philadelphia.

Martin S. O'Connor has been promoted from the position of foreman in the Avis, Pa., shops of the Pennsylvania division, New York Central Lines, to that of general foreman of the Highbridge, N. Y., shops of the Putnam division.

A. F. Cook, general car foreman of the Chicago division of the C. B. & Q. R. R., has taken charge of the car department of the Chicago & Western Indiana R. R. and the Belt Ry. Co. of Chicago, with headquarters in Chicago.

Dr. William H. Tolman, director of the Museum of Safety, New York, sailed for Europe May 12 with a commission from the National Electric Light Association to investigate European methods of protection of life and limb in electric plants.

John R. Back has resigned his position as instructor in the Worcester trade school, Worcester, Mass., and Mr. M. L. Carroll has been elected to the position. Mr. Back, who was for many years superintendent of the F. E. Reed Co., has entered the employ of Prentice Bros. Co., Worcester.

J. B. Comstock, for six years with the Westinghouse Electric & Mfg. Co. at its East Pittsburg Works, and for four years manager of its publication department and printing plant, severed his connection with that company in April to take a similar position with the P. & F. Corbin Co. of New Britain, Conn. Prior to Mr. Comstock's connection with the Westinghouse Co. he filled the position with the Corbin Co. that he has recently been recalled to assume.

S. Noda, president of Roku-Roku Shoten, Inc., machinery merchants, 3 Shinsakancho Kyopashiku, Tokio, Japan, visited a number of American machine tool manufacturers in May, whom he will represent in Japan. He sailed the last of May for Germany with the intention of attending the Brussels Exposition. Mr. Noda has thoroughly equipped himself for handling machine tool business in Japan. He speaks English and German fluently. His brother is spending three years in the machine shops of the United States to obtain a thorough practical knowledge of machinery manufacturing and operation, particularly the latter. It is his intention to cooperate with his brother in selling machine tools. His practical experience will enable him to get the best possible results from American machinery. In many cases, at present, machine tools are being operated in Japan very inefficiently, no one in charge being competent to work them to the best advantage.

OBITUARIES

Thaddeus W. Tyler, the original of Longfellow's "Village Blacksmith," died at Lynn, Mass., in April, aged seventy-six years.

John I. Kinsey, who for forty years was master mechanic of the Lehigh Valley R. R. shops at Easton, Pa., died in Easton, April 28, aged eighty-three years.

Charles W. Gage, an expert draftsman, employed by the George H. Bushnell Press Co., Thompsonville, Conn., died at his home in Thompsonville April 15, aged forty years.

Leonard B. Spence died in New York, April 16, aged seventy-two years. Mr. Spence was a pioneer manufacturer of mowing machines and made, in Worcester, Mass., some of the first machines for cutting grass produced in New England. He had been connected with the New York Aquarium for fifteen years as a scientist.

James W. Van Cleave, president of the Bucks Stove & Range Co., St. Louis, Mo., and former president of the National Association of Manufacturers, died at his home in St. Louis, of heart disease, May 15, in his sixty-first year. A memorial service was held by the association, which was in convention at the Waldorf-Astoria hotel in New York, at four o'clock, May 17, just at the time the burial was taking place in St. Louis. Van Cleave will be remembered as one of the great fighters of unions and union labor. His labor troubles undoubtedly shortened his life.

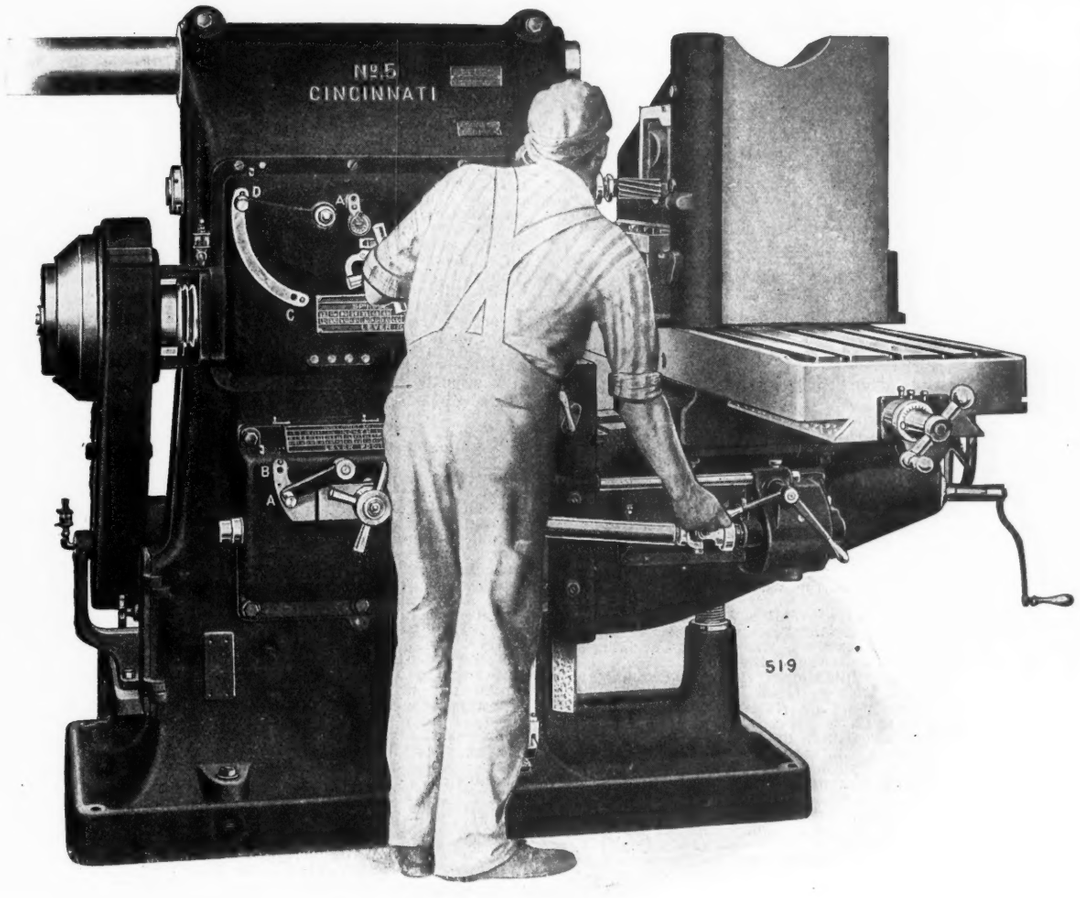
John Wilson Wheeler, president of the New Home Sewing Machine Co., Orange, Mass., died at his home in that town May 2, aged seventy-seven years. Mr. Wheeler left the mercantile business in 1867 to engage in the manufacture of sewing machines in Orange, Mass. Mr. Thomas White, of the White Sewing Machine Co., Cleveland, Ohio, is the only survivor of the company. These pioneers began the business in a very small way, making small hand sewing machines. The business in Orange grew from this small beginning to the present capacity of 600 machines a day and the employment of over 800 people. Mr. Wheeler worked unceasingly to build up the business, first as secretary and treasurer, and then as president for the past ten years.

John H. Converse, president of Burnham, Williams & Co., Philadelphia, Pa., died suddenly of heart disease at his suburban home in Rosemont, May 3, aged sixty-nine years. Mr. Converse was born in Burlington, Vt., and graduated from the University of Vermont in 1861. His first employment was in newspaper work as an editorial writer on the *Burlington Times*, where he stayed for three years. He then went to Chicago, where he engaged in railroad work for two years with the Chicago & Northwestern Ry. Co. In 1866 he went to Altoona, Pa., to work for the Pennsylvania R. R. Co. In 1870 he became a member of M. Baird & Co., Philadelphia, afterwards Burnham, Parry, Williams & Co., and now Burnham, Williams & Co., builders of Baldwin locomotives. The growth of the company during Mr. Converse's regime was enormous, the production increasing from less than one locomotive a day to seven or eight a day in the most prosperous times.

WALTER CRAIG KERR

Walter C. Kerr, president of the Westinghouse Church Kerr & Co., 10 Bridge St., New York, died on May 8 at Rochester, Minn., where he had gone two months previous to undergo an operation for cancer. Mr. Kerr was born at St. Peter, Minn., in 1858. He received his early education in the public schools of his birthplace and took a course in mechanical engineering at Cornell University, graduating in the class of 1879. After his graduation he remained at Sibley College as an instructor and assistant professor until the organization of Westinghouse Church Kerr & Co. was effected in 1884, when, from the first, Mr. Kerr was one of the officers of that

Cincinnati Handiness



WHEN you have a job of end or face milling to do on a Horizontal Miller, don't you find it hard to operate the feed lever and at the same time keep your eye on the cutter? That's because the machines you are using can be operated from only one place. Our new High Power Machines have an additional feed lever at the side of the knee.

The operator can stand close up to his work, with the cutter in full view, and control the machine from this position.

With this one lever he can operate and reverse table, cross or vertical feeds.

The main starting lever is immediately in front of him and the speed and feed changers are at his elbow, so that the entire machine is under complete control from here.

Ask for the Catalog.

The Cincinnati Milling Machine Company

Milling Specialists

CINCINNATI, OHIO, U. S. A.

EUROPEAN AGENTS—Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg, Copenhagen and Budapest. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Paris, Turin, Barcelona and Bilbao. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow.

CANADIAN AGENT—H. W. Petrie, Ltd., Toronto, Montreal and Vancouver.

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Walter Craig Kerr

firm. Much of the credit for the growth and success of this company, of which Mr. Kerr was long president, was due to him.

Mr. Kerr was one-time vice-president of the Westinghouse Machine Co., and at the time of his death was a director of the Electric Properties Co. Since 1890 he had been a trustee of Cornell University. He was a member of the American Society of Mechanical Engineers and of various other engineering societies and clubs. He is survived by a widow, one son and three daughters.

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COMING EVENTS

May 31-June 3.—Spring meeting of the American Society of Mechanical Engineers, Atlantic City, N. J.

June 1-4.—Second annual state convention of Pennsylvania engineers, for the furtherance of the organization of the Engineers Society of Pennsylvania, Hall of Representatives, Harrisburg, Pa. Engineers Society of Pennsylvania, Gilbert Building, Harrisburg, Pa.

June 6-10.—Convention and exhibition of the Foundry and Manufacturers' Supply Association, Detroit, Mich. C. E. Hoyt, secretary, Lewis Institute, Chicago, Ill. Cadillac Hotel, Detroit, headquarters of the association convention week.

June 7-9.—Convention of the American Foundrymen's Association and American Brass Founders' Association, Detroit, Mich. Headquarters, Hotel Ponchartrain. Richard Moldenke, secretary, American Foundrymen's Association, Watchung, N. J. W. M. Corse, secretary, American Brass Founders' Association.

June 13-16.—National Gas and Gasoline Engine Trades Association convention at Cincinnati, Ohio, Hotel Sinton, headquarters. Albert Stritmatter, Cincinnati, Ohio, secretary.

June 15-17.—Annual convention Master Car Builders' Association, Atlantic City, N. J. J. W. Taylor, secretary, Old Colony Building, Chicago, Ill.

June 20-22.—Annual convention of the American Railway Master Mechanics' Association, Atlantic City, N. J. J. W. Taylor, secretary, Old Colony Building, Chicago, Ill.

June 20-July 6.—Detroit Industrial Exposition, Detroit, Mich., under the auspices of the Detroit Board of Commerce to accelerate the city's industry and commerce. The exposition grounds will be on the Detroit River where a large exposition building is being erected to be used in conjunction with the Wayne Pavilion. W. G. Rose, manager, Detroit Board of Commerce, Detroit, Mich.

July 26-29.—Joint meeting of the American Society of Mechanical Engineers and the British Institute of Mechanical Engineers in Birmingham and London, England.

August 16-19—Annual convention of Traveling Engineers' Association, Clifton Hotel, Niagara Falls, Canada. Subjects to be discussed are: "Fuel Economy," "Superheating," "Education of Firemen," "Development of Air Brake Equipment," "Locomotive Lubrication," and "New Valve Gears." W. A. Thompson, secretary, N. Y. C. Car Shops, East Buffalo, New York.

NEW BOOKS AND PAMPHLETS

COST OF LIVING TO RAILWAYS. By Edward W. Harden. 8 pages, 6 x 9 inches. Reprinted from the *Outlook*, New York.

NATIONAL VITALITY: ITS WASTES AND CONSERVATION. By Irving Fisher. Document No. 419 issued from the Government Printing Office, Washington, D. C.

TESTS OF WASHED GRADES OF ILLINOIS COAL. By C. S. McGovney. Bulletin No. 39. 146 pages, 6 x 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill.

The bulletin presents the results of an elaborate series of boiler tests made in connection with a 210-horsepower brick set water-tube boiler, equipped with chain grate stoker. A description of the method employed and the results of the tests are given in detail.

STUDY IN HEAT TRANSMISSION. By J. K. Clement and C. M. Garland. Bulletin No. 40. 17 pages, 6 x 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill.

The bulletin describes the method of studying the effect of agitation of a medium in contact with metal walls upon the heat conducted through these walls and to or from the medium. Experiments were made on a one-inch steel tube through which water flowed at different velocities. A record of the amount of heat transmitted was obtained from the weight of the water and rise in temperature while passing through the tube.

ORNAMENTAL CONCRETE WITHOUT MOLDS. By A. A. Houghton. 132 pages, 5 x 5½ inches. 30 illustrations. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price $2.

The process of making ornamental concrete without molds has long been held a secret, it is said. It is now given to the public in a practical treatise and is said to be the only work issued which explains simple and practical methods whereby concrete-workers are enabled, by using wooden and metal templets of different designs, to mold or model in concrete any cornice, archivolt, column, pedestal, base, cap, urn or pier in monolithic form. Full directions are given for making templets at very slight cost of time and labor.

DYNAMO BUILDING FOR AMATEURS. By A. J. Weed. 83 pages, 5 x 7½ inches. 64 illustrations. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price $1 in cloth, and 50 cents in paper.

The book gives a general description of a 50-watt dynamo and describes its building in detail, telling of the tools and material required. Separate chapters are devoted to side-bearing rods, field punchings, bearings, commutator, pulley, brush holders, connection board, armature shaft, armature, armature winding, field winding, connections and starting. The book is one that should enable an amateur to proceed intelligently in the making of a working dynamo capable of lighting six 6-candle lamps. Various operations are made plain by halftone illustrations and drawings.

SELF-TAUGHT MECHANICAL DRAWING AND ELEMENTARY MACHINE DESIGN. By F. L. Sylvester, with additions by Erik Oberg. 333 pages, 5 x 7½ inches. 218 illustrations. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price $2.

This comprehensive and well-prepared work has been published to meet the demand for an elementary treatise on mechanical drawing, including the first principles of machine design. The opening chapters are devoted to mechanical drawing pure and simple, taking up instruments and materials, definitions of terms used in geometrical and mechanical drawing, geometrical problems, projection, and working drawings. The following chapters are on algebraic formulas, elements of trigonometry, elements of mechanics, first principles of strength of materials, cams, sprocket wheels, general principles of gearing, calculating the dimensions of gears, cone pulleys, bolts, studs and screws, couplings and clutches, shafts, belts and pulleys, flywheels for presses, punches, etc., trains of mechanism and quick-return motions. The work should be well-suited to the class for which it is intended. The mathematics are simple and readily understandable. It can be specially recommended to those desirous of improving their mechanical education by home study.

SAFEGUARDS FOR THE PREVENTION OF INDUSTRIAL ACCIDENTS. Edited by David Van Schaak. 174 pages, 6¾ x 9¾ inches. 168 illustrations. Published by the Aetna Life Insurance Co., Hartford, Conn. Price 50 cents.

The importance of promoting the movement for the prevention of industrial accidents has been fully realized by the great accident and liability insurance companies and a concerted movement is being made to induce manufacturers to supply guards for gears, belts, moving chains, elevators, set-screws, and other potentially dangerous things. Accidents may be attributed to the following principal causes: Ignorance, carelessness, unsuitable clothing, insufficient lighting, defects of machinery and structures, insufficient room, unclean conditions, and lack of good air. The work treats of these subjects and gives general suggestions for safeguarding all classes of machinery. A large number of illustrations are given, showing methods of guarding gears on slitting machines, rolling mills, slotting machines, gear cutters, lathes, wall-paper printing machines, tumbling barrels, pipe threading machines, boring mills, twisters, baling machines, looms, etc. Chapters are devoted to flywheels, driving belts, set-screws, sprocket wheels, rolls and knives, punch presses, stairways, platforms and runways, elevators, contracting, bake-shops, and miscellaneous. The concluding chapter is on rules and regulations, instructions, warning notices, etc. The book is one that every manufacturer, superintendent and shop foreman should read and study. If the suggestions contained therein were followed, most of the distressing industrial accidents would be avoided.

CATALOGUES AND CIRCULARS

BRISTOL CO., Waterbury, Conn. Bulletin No. 124 illustrating Bristol's atmospheric recording thermometer.

TERRELL'S EQUIPMENT CO., Grand Rapids, Mich. Folder illustrating steel wardrobes, steel lockers, and steel shelving and bins.

PETER GERLACH CO., Cleveland, Ohio. Catalogue of circular and cylinder saws, stave heading and barrel machinery, and saw and logging tools.

AMERICAN BLOWER CO., Detroit, Mich. Catalogue of "Sirocco" electric fan and air purifier for insuring absolute ventilation in offices all the year round.

NORTHERN ENGINEERING WORKS, Detroit, Mich. Catalogue of the Newten cupola having a differential adjustable tuyere system and an all-steel air chamber.

WILEY & RUSSELL MFG. CO., Greenfield, Mass. Circular of "Green River" opening die bolt cutter, nut tapper, pipe threader and cutting-off machine No. 55.

LANDIS MACHINE CO., Waynesboro, Pa. Catalogue of bolt threading, pipe and nipple threading, bolt pointing and nut tapping machinery, and special threading machines.

CROCKER-WHEELER CO., Ampere, N. J. Bulletin No. 124 superseding No. 112 on exhaust fans. The motors of these fans are built for durability and are practically "fool-proof."

DODGE MFG. CO., Mishawaka, Ind. Pamphlets entitled "Friction Clutches," "Safe Construction and Speeds for Flywheels," "From Log to Lineshaft," and "Dividends and Drives."

T. R. ALMOND MFG. CO., Ashburnham, Mass. Circular of Almond three-jaw geared drill chuck made in two sizes having capacities from 0 to 5/16 inch and 0 to ½ inch respectively.

CROCKER-WHEELER CO., Ampere, N. J. Bulletin No. 119 superseding No. 107 on direct-current lighting and power generators; also Bulletin No. 121 on small engine type direct-current generators.

JOYCE-CRIDLAND CO., Dayton, Ohio. Catalogue of lifting jacks, including hydraulic jacks, lever jacks, automatic jacks, geared automatic jacks, screw jacks, traversing jacks, journal jacks, navy jacks, etc.

BICKFORD & WASHBURN INC., Greenfield, Mass. Catalogue of thread milling machines, index centers for fluting taps and reamers, open die for threading small taps, solid adjustable die and upright threader.

PAWLING & HARNISCHFEGER CO., Milwaukee, Wis. Folder illustrating line of horizontal drilling and boring machines, recommended for drilling all classes of work. The drill capacities range from ⅜ inch up to 3 inches.

LUCAS MACHINE TOOL CO., E. 99th St., and L. S. & M. S. Ry., Cleveland, Ohio. Circular No. E-2 of No. 21 precision boring, drilling and milling machines, illustrating the cone drive, and constant-speed drive and gear box types.

NATIONAL-ACME MFG. CO., Cleveland, Ohio. Leaflet illustrating a piece formed complete on the Acme multiple-spindle automatic screw machine on which circular forming, taper forming, drilling and facing operations are performed.